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B. T. GALLOWAY, *Chief of Bureau.*

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# THE KAOLIANGS:

## A NEW GROUP OF GRAIN SORGHUMS.

BY

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Broom-Corn Investigations.*



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## BUREAU OF PLANT INDUSTRY.

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<sup>1</sup> On July 1, 1912, the name of this office was changed from "Grain Investigations" to "Cereal Investigations."

## LETTER OF TRANSMITTAL.

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U. S. DEPARTMENT OF AGRICULTURE,  
BUREAU OF PLANT INDUSTRY,  
OFFICE OF THE CHIEF,  
*Washington, D. C., April 27, 1912.*

SIR: I have the honor to transmit herewith a manuscript entitled "The Kaoliangs: A New Group of Grain Sorghums," and to recommend that it be published as Bulletin No. 253 of the series of this Bureau. This bulletin was prepared by Mr. Carleton R. Ball, Agronomist in Charge of Grain-Sorghum and Broom-Corn Investigations in the Office of Grain Investigations, and has been submitted by Mr. Mark Alfred Carleton, Cerealist in Charge of Grain Investigations, with a view to its publication.

The kaoliangs comprise a new group of grain-producing sorghums from eastern Asia. During the past few years a large number of varieties and strains of this group have been introduced into the United States from China and Manchuria. Most of these introductions have been carefully tested for agronomic value in comparison with milos, kafirs, and durras. All of the varieties are drought resistant. Some of them are very early and therefore adapted to higher elevations and more northern latitudes than the members of other groups. The better sorts are now becoming distributed among farmers and it is desirable to publish a description of them and their adaptations and to point out the conditions under which they are most likely to prove of value.

In dealing with this new group it was necessary to make a very comprehensive varietal study in connection with the work of agronomic improvement. In order to make permanent the records concerning the whole series of about fifty introductions, a description of each is given under the serial number used to designate it by the Office of Foreign Seed and Plant Introduction of this Bureau.

Thanks are due to the many explorers, missionaries, consular officers, and others who have assisted in procuring the seeds of these varieties. Full acknowledgment of their assistance has been made in connection with the description of the various introductions. The author wishes also to express his obligation to Miss M. E. Holland for

assistance in determining the colors of the seeds and glumes and to Mr. B. E. Rothgeb and Mr. Karl H. Townsend for assistance in measuring plants, leaves, panicles, and seeds.

Figures 1, 2, 3, 4, 5, 6, 7, and 13 are from photographs made or obtained in China by Mr. Frank N. Meyer, Agricultural Explorer of this Bureau.

Respectfully,

B. T. GALLOWAY,  
*Chief of Bureau.*

Hon. JAMES WILSON,  
*Secretary of Agriculture.*

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# THE KAOLIANGS: A NEW GROUP OF GRAIN SORGHUMS.

## INTRODUCTION.

The kaoliangs comprise a group of grain-producing sorghums only recently introduced into cultivation and entirely new to the literature of this country. For about 13 years various agencies employed by or cooperating with the United States Department of Agriculture have been forwarding samples of kaoliang seed. These seeds have been sown at various points and the resulting crops studied from the two standpoints of relationship and value. Many data have been accumulated. Some of the varieties have been found to be of agronomic importance in parts of the United States. Since they have now become the property of both experimenters and farmers, it is desirable to present all available data on the group. There follows a brief discussion of the origin, culture, and use of the kaoliangs in their native home and a full description of the important varieties and their adaptations in this country. To this discussion is appended a description of all introductions made, so far as the records are available.

## KAOLIANGS IN EASTERN ASIA.

With the exception of a single variety of sorgo,<sup>1</sup> which is grown locally on Tsungming Island in the mouth of the Yangtze River and occasionally on the adjacent mainland, the kaoliangs are the only sorghums found in eastern Asia, including the Chinese Empire, Japan, and Siberia.

## NAMES.

The Chinese name for this group of plants is "kao-liang," meaning, literally, tall millet and pronounced kōw-lī-ang. This has been written in other similar forms, as "kauliang," "kaulien," "gaolan," "gaolien," "goolan," etc. These may represent slight differences in pronunciation by different Chinese or they may be merely the different attempts of Americans to reproduce phonetically the Chinese name.

Among the names applied to kaoliang by Europeans in the East are "tall millet," "great millet," "large millet," "giant millet,"

<sup>1</sup> Ball, Carleton R. The History and Distribution of Sorghum. Bulletin 175, Bureau of Plant Industry, U. S. Dept. of Agriculture, 1910, pp. 24-25, 32-33, and fig. 9.

"false millet," and "Barbados millet." Most of these names are used to distinguish it from the smaller species of millet which are also commonly cultivated throughout China and in other parts of Asia as well. These species are *Panicum miliaceum* (proso) and *Chaetochloa* (*Setaria*) *italica* (foxtail millet). The use of the term "Barbados millet" by foreigners in China was noted previous to 1866 by Doolittle,<sup>1</sup> who says:

The so-called Chinese sugar cane or sorghum is grown very extensively in northern China and is known among foreigners as a kind of millet—the Barbados millet. The Chinese name for it is kaoliang.

The name probably arose from the resemblance of certain kaoliangs to that kafir variety grown in Barbados and other islands of the West Indies with which some English residents of China were probably somewhat familiar.

It should be noted here that varieties of kaoliangs have been frequently written about and their seeds sent to this country under the name "glutinous millet." This is an error that has probably arisen through a misapprehension of the species really called "glutinous millet" by the Chinese, probably *Panicum miliaceum*. The venerable Dr. S. P. Barchet, of Shanghai, stated the matter tersely in conversation with the writer, as follows: "The large millet of Shantung Province is not glutinous; the glutinous millets are not sorghums." So far as studied, the seeds of kaoliangs, in common with those of all other groups of sorghums, are comparable to maize in chemical composition and are never gluten bearing, as are the seeds of wheat, for example.

In Japan the general term applied to sorghum is "morokoshi," according to the statements made by Dr. Sawano,<sup>2</sup> of the imperial experiment station at Tokyo, in transmitting three samples of the seed, viz, Agrostology Nos. 1584 to 1586. These three were further designated as "sato-morokoshi" or sugar sorghum; "hoki-morokoshi" or broom sorghum, and "kibi" or "to-kibi," millet or tall millet, respectively. For his full statements, consult these numbers and also Agrostology No. 1576 in the descriptive list of introductions. Rein<sup>3</sup> uses the term "morokoshi" and also "taka-kibi," or high millet.

#### ORIGIN.

It is probable that this group of sorghums was originally brought into China from India. There is evidence,<sup>4</sup> however, that this introduction took place many centuries ago and that the forms as we now find them in China and Manchuria probably vary considerably from

<sup>1</sup> Doolittle, Justus. Social Life of the Chinese, 1866, p. 43; revised edition, by E. P. Hood, 1868, p. 25.

<sup>2</sup> Sawano, J., in letter of April 23, 1903.

<sup>3</sup> Rein, J. J. Industries of Japan, 1889, p. 51.

<sup>4</sup> Ball, op. cit., pp. 11, 24.

the original importations. Among several hundred varieties of sorghum imported into the United States from India and carefully studied varietally, no duplicates of the Chinese kaoliangs have been found. This fact is not surprising if 10 or 15 centuries have elapsed since their translocation from India to China took place.

#### DISTRIBUTION.

The Chinese Empire (Pl. I) has an extreme breadth from south to north of about 2,300 miles, or about 2,500 miles if the island of Hainan is included. The southern boundaries of the provinces of Yunnan and Kwangsi are approximately  $21^{\circ}$  north latitude, while the northern extremities of Mongolia and Heilungkiang Province in Manchuria reach  $54^{\circ}$  north latitude. The length of the empire from east to west is, roughly, 3,200 miles. The most eastern point of Kirin Province, Manchuria, touches the meridian of  $135^{\circ}$  east longitude, while the most western extremity of Chinese Turkestan has less than  $74^{\circ}$  of east longitude.

In general, the topography of the empire is a series of elevated mountain ranges and plateaus in the central and western parts, declining gradually eastward to a broad and fertile alluvial plain of low elevation. This plain has such a gentle gradient as to make part of it subject at times to disastrous overflow and consequent famine.

From the reports of explorers, missionaries, and others it is known that the kaoliangs are grown more or less extensively over most of the eastern half of the empire.

In China proper they are found from Yunnan, which is the most southwestern province and adjoins Tibet on the southeast, to Chihli in the north and thence south to Shantung and Chekiang. They appear to be found only rarely or not at all in the southeastern alluvial provinces from Fukien and Kiangsi on the east to Kwangtung and Kwangsi on the southwest. These provinces comprise part of the great rice-growing area of China. In general the kaoliangs become increasingly important westward in the piedmont areas up to prohibitive elevations and northward with increased latitude and shorter seasons.

Much has been written about the kaoliangs in North China and Manchuria, but very little about their occurrence in western China. The following note by Wilson,<sup>1</sup> who had then traveled five years in the provinces of Yunnan, Szechwan, and Hupeh, in southwestern China, will be of interest. He says, under the heading "False millet":

This is the kaoliang of the Chinese, which is largely used in China for making wine. It is cultivated generally throughout central and western China, but not so extensively as in other parts of China, notably Manchuria. The largest areas I noted

<sup>1</sup> Wilson, E. H. Leaves from My Chinese Notebook. *Gardeners' Chronicle*, September, 1905, vol. 38, p. 246.



were on the plateaux of Yunnan, the plain of Chentu <sup>1</sup> and the fluvial areas of the Min and Fo Rivers. Its altitudinal limit is the same as that of maize and, like this latter, it is always a summer crop.

It is in the province of Manchuria, however, that these crops are most abundantly grown and become highly important staples on the farm. They are found commonly in Chosen (Korea) also, and to a lesser extent in Japan. Just to what extent they are grown in Siberia, above the borders of Manchuria and Chosen (Korea), is not known. Seed has been obtained from Usuri Province, northeast of Chosen, and also (S. P. I. No. 939) from Nertchinsk in Trans-Baikalia, at 51° north latitude. It is not stated, however, in either case whether it was grown in these provinces or merely imported as a cereal.

Kaoliang was prominently mentioned in Manchuria under the name "tall millet" during the progress of the Russo-Japanese War. This fact developed from the frequent maneuvering of infantry, and even of cavalry also, under cover of the shelter afforded by fields of this tall-growing crop.

#### CULTURE.

While the native methods of growing the kaoliang crop would seem rather crude to the American farmer, accustomed to the use of improved machinery, they are really quite thoroughly systematized. So far as the practices obtaining in Manchuria are concerned, the writer can do no better than quote from a paper by the consular officer of the United States at Newchwang. Manchuria is the banner kaoliang-producing region and Newchwang is not only situated in the region of production but is the port through which most of the Manchurian exports pass. The report of Consul General Sammons <sup>2</sup> is as follows:

*Holcus sorghum*, or tall millet.—*Holcus sorghum*, or tall or giant millet, of which the Chinese name is kaoliang, is planted in drills in the deep, rich loam throughout Manchuria. The seed is sown by hand and is then covered with manure. Stone rollers are then passed over the drills. When the shoots are 2 or 3 inches high they are thinned to about 18 inches apart. The weeds are carefully destroyed, and, except the earthing up of the roots or "hilling" the plants, as in caring for Indian corn in the United States, no further attention is required until harvest time in September. Should there be heavy rains in May the plants may be greatly damaged by roots losing their hold on the soil, resulting in the plant being blown over. Too much rain or a lack of rain may prevent the seed from ripening; but as a rule, as is the case this season, a good crop is secured.

During the early part of September, the stalks, having reached a height of from 8 to 10 feet, and the heads having turned purple—caused by the small, dark purple cases which contain the grain—they are cut down near the roots. This usually takes place toward the close of the month. The process of thrashing consists of cutting off the

<sup>1</sup> Chentu (Chengtu) and the Min and Fo (Fu) rivers are in Szechwan.

<sup>2</sup> Sammons, Thomas. Manchuria: Manufactures and Agriculture. Monthly Consular and Trade Reports, No. 301, October, 1905, pp. 52-54.

heads of the stalks, spreading them on the floor, and thrashing them with a stone roller drawn by some domestic animal. This is completed in about four hours. The grain is then passed through a winnowing machine or tossed up in the air, after being separated from the empty heads, which are used either for fuel or in the manufacture of brooms. The now cleaned, but unhusked, grain is put in sacks and is ready for the market, being sold for fodder. To be fit for human consumption it must still pass through the process of husking, which consists of placing the grain on a circular stone floor, passing a circular stone roller over it, which crushes the husks, and separating the grain from the husks.

It is estimated that 8 pounds of the seed will sow an acre of ground and that the yield in grain will be half a ton if the crop is good. There is in Manchuria practically an inexhaustible supply of giant millet stalks, but these stalks are by no means a valueless or useless quantity. It is estimated that the product of an acre (6 Chinese mu) will weigh from  $1\frac{1}{4}$  to  $1\frac{1}{2}$  tons of 2,000 pounds. The value of the dry stalks is approximately \$5 gold per ton. The stalks are usually sold in bundles of about 10 stalks. In the Chinese method of reckoning there are about 75 bundles to each mu, and 100 of these bundles to 320 catties (a catty is equal to  $1\frac{1}{3}$  pounds). The native price is \$1 to \$2.50 (Mexican) to the 100 bundles, equivalent to 50 cents to \$1.25 gold.

Mr. Frank N. Meyer, Agricultural Explorer of this Bureau, who has traveled widely in Manchuria and North China, has kindly furnished the following original account of the culture of kaoliang in those areas:

It seems that sorghum was introduced into China from India in the second century of our calendar. It soon spread until now it has become the staple crop of the North, and it has developed a great number of varieties. The shortest variety I ever saw was found growing along the coast of Shantung and was barely three feet in height, with very dense heads of seeds, while on some of the low, rich land near Tientsin varieties may be found that tower 20 feet in height and often have loose, spreading heads. Then there are white, light-brown, and dark-brown seeded varieties, and forms with white, brown, and black hulls; erect-headed ones, drooping ones, and hybrids between all of them. [See fig. 1.] In some fields, where the grower has not been very careful about the selection of his seeds, one might easily find 30 or 40 different forms in an hour's time, some even ripening fully a fortnight later than others, which can be explained by the fact that the Chinese only cut those heads that are ripe, leaving the others to ripen later on. Later, the seeds of both early and late sorts are often mixed together again, and the next year's crop is still worse in irregularity of ripening.

The method of growing the kaoliang in North China is as follows: The soil on which the grain is going to be planted has been plowed in the autumn, has lain rough and unbroken during the winter, and is manured and plowed in the spring. During the month of May the seeds which, by the way, often have been soaked in water overnight, are sown in rows in hills 2 to 3 feet apart, and the rows always run north and south. A few days later the young plants appear above the ground. They do not make much growth until the first summer rains, which usually begin in the latter part of June, although also often not until early July. The fields are regularly hoed and cultivated, even if the plants do not make much progress. When once the rains have started, however, the young sorghum shoots up with an amazing quickness and can almost be seen to grow.

As soon as the plants are a foot or so high, the hills are thinned and generally only one plant is left. By about the middle of August the kaoliang has headed and when the seeds have set well a few weeks later, one may see in large fields hundreds of

workingmen pulling off the leaves from the plants, leaving only a few at the top. The Chinese claim that if they did not do this the grain would not ripen and the soil would not dry sufficiently to keep the plants healthy. Whatever truth there may be in this I do not know, but the fact is that these leaves are most carefully dried, packed



FIG. 1.—Field of kaoliang 10 feet high, in the vicinity of Harbin, Manchuria. (Photographed by Frank N. Meyer.)

into bundles, and kept as a winter food for the domestic animals. In a country without meadows, like China, these leaves take the place of hay.

When the seeds are at last sufficiently ripe, armies of men turn out again in the fields, and either cut the whole plants down and let them dry in sheaves, which method they use in the larger fields of Manchuria [see figs. 2 and 3], or, where the population is



dense and the fields smaller, the people cut off the heads first and store them away in safety, for there is much crop robbing in China. Later on they come back and cut the stalks down.

These harvested heads are spread out every day in the sun, in the yards, on matting, etc. When sufficiently dry, they are spread out again on a clay thrashing floor, and stone rollers [see fig. 4] hitched to horses, mules, donkeys, old men, women, or boys, are dragged over them. In this primitive way the seeds are thrashed out and later on winnowed, all by hand labor, and, when clean, are stored away in earthen jars, in baskets smeared over with clay, and in sacks. They form a very important item in the agricultural productions of Manchuria and North China.

The method of culture employed on Tsungming Island in the mouth of the Yangtze River, Kiangsu Province, China, is briefly



FIG. 2.—Hauling the kaoliang crop from the field on a two-wheeled cart, Harbin, Manchuria. (Photo graphed by Frank N. Meyer.)

given by Dr. S. P. Barchet,<sup>1</sup> interpreter at the American consulate, Shanghai, in transmitting the seed of two varieties, S. P. I. Nos. 22911 and 22912. He writes:

The white variety (S. P. I. No. 22912) is considered inferior to the red (S. P. I. No. 22911, Brown), though planted in the same way. It is planted in richly manured land, in rows 6 inches wide covered lightly with half an inch of earth. If plants come up too thick or crowded, the plants which should be removed are not pulled, but cut off with a sharp knife, so as not to disturb the roots of neighboring plants.

In Japan, as noted, the sorghum plant is not widely distributed and it is only sparingly cultivated in the localities where it has been introduced. Rein<sup>2</sup> states:

Guinea corn or Durrah, Japanese morokoshi (*Sorghum vulgare*, Pers[e]; *Holcus sorghum*, L.), called also taka-kibi (high millet), is of only small importance for Japan.

<sup>1</sup> Seeds and Plants Imported during the Period from April 1 to June 30, 1908. Bulletin 142, Bureau of Plant Industry, U. S. Dept. of Agriculture, 1909, pp. 42-43.

<sup>2</sup> Rein, J. J. Industries of Japan, 1889, p. 51.

This grain is seldom found except along the borders of fields, encircling them in a furrow, and even this but rarely. It is raised in April, in a seed bed. Later, having attained a height of about 15 cm., it is transplanted at intervals of from 25 to 30 cm. It is harvested in September. The same holds good for the long-panicked form, the broom corn, so often grown in northern Italy, and of whose panicles brooms are also made in eastern Asia.

Consul General Bellows,<sup>1</sup> of Yokohama, in transmitting the seed of *Agrostology* No. 1576, says:

I have the honor to transmit a package of Japanese sorghum seed of the kind known as "morokoshi kibi." Messrs. L. Boehmer & Co., horticulturists, of Yokohama, who have furnished this seed without charge, inform me that this sorghum "is of very little importance in Japan, being generally planted along the borders of fields only, in order to protect the field crops against winds, etc. In some parts of the country where rice



FIG. 3.—Field of kaoliang curing in the shock, Harbin, Manchuria. (Photographed by Frank N. Meyer.

and other cereals do not grow sorghum is to a certain extent cultivated as a field crop. It is sown in April in seed beds and later transplanted at intervals of 8 or 10 inches."

Of the *sato-morokoshi*, or sugar sorghum (*Agrostology* No. 1584), Dr. Sawano<sup>2</sup> says:

This plant was introduced to this country from China about 28 years ago. For many years we tried to prepare sugar from it in many localities, but with poor success, on account of climatic and other circumstances. At the present time it was difficult to obtain even the small quantity sent.

The 28-year period mentioned by Sawano dates almost exactly from the publication of Collins's<sup>3</sup> paper on the Chinese sorgho, which

<sup>1</sup> E. C. Bellows, in letter of March 6, 1903.

<sup>2</sup> Letter from J. Sawano, April 23, 1903.

<sup>3</sup> Collins, Varnum D: Sorgho, or the Northern Chinese Sugar Cane. *Journal of North China Branch, Royal Asiatic Society*, n. s., vol. 2, December, 1865, p. 91.



doubtless led the Japanese to investigate the saccharine variety of China. Be that as it may, the sample sent was not the Chinese sorgo, but a Brown kaoliang, different from the other (No. 1586) which accompanied it.

Of the tall millet, or to-kibi, Sawano says:

It is generally planted along the boundary of a farm plat as a wind shelter for another principal summer crop. Its cultivation is very easy, and, indeed, the farmer does not pay much attention to it. In May or June the seeds are sown in one or two rows. It is harvested about October or November, when the heads turn yellowish in color.

#### USES.

The primary use of the kaoliang crop throughout most of the region where it is grown is for human food and the feeding of farm animals.



FIG. 4.—Thrashing kaoliang seed from the harvested heads by means of stone rollers drawn by horses or mules, near Harbin, Manchuria. (Photographed by Frank N. Meyer.)

It has, however, a great many secondary uses, due to the ingenuity and thriftiness of the Chinese in matters of economic detail. Its importance to the people of Manchuria and the uses to which they put it are well shown in the following quotation from Consul General Sammons,<sup>1</sup> of Newchwang:

The giant millet is no doubt the most valuable product of Manchuria to the natives. It is the staple food—that is, the seed—of the people, and is fed likewise to the beasts of burden. The seed is also used in distilling spirits or *sanshu*. Practically all of the giant millet is consumed in the country where it is raised in such great abundance. The stalks are not only used for fuel in winter, but in making mats. These are manufactured by hand from the outer leaves. Compound or yard fences [fig. 5] are made from the stalks. They also enter into house building and in constructing small bridges. Even the roots are used. In the spring when the fields are plowed the

<sup>1</sup> Sammons, *op. cit.*, pp. 53-54.

roots are saved and burned for fuel. \* \* \* The empty heads are used either for fuel or in the manufacture of brooms.

The missionary previously mentioned, Mr. Doolittle, writing of the native life and customs in Fukien Province in 1866, says,<sup>1</sup> concerning the uses of kaoliang by the people of northern China:

They make a coarse kind of bread from the flour of the seed of the kauliang, eaten principally by the poorer classes. The best kind of Chinese whisky, often called Chinese wine, is distilled from the seeds. The stalks are used for fuel, for lathing in the partitions of houses, for slight and temporary fences, etc. Numerous and



FIG. 5.—Kaoliang stalks used as a fence at Changli, Chihli, China, October 11, 1907. (Photographed by Frank N. Meyer.)

immense fuel yards, consisting entirely of the dried stalks of the kauliang, are found at Tientsin and many other cities in the north of China.

Mr. Frank N. Meyer, Agricultural Explorer for the Office of Foreign Seed and Plant Introduction of this Bureau, has accumulated interesting information and photographs showing the uses of kaoliang in North China. In transmitting S. P. I. No. 17921, a brown-seeded sort collected at Peesan, Chihli, he states:<sup>2</sup>

(No. 22, *a.*) A variety with dark-brown seeds, universally used throughout North China as fodder for domestic animals. The stems of sorghum are used in building houses, the stalks being embedded in the mud walls; also for making fences, baskets, mats, tying and roofing material, and for fuel.

Figures 5 and 6 illustrate the use of stalks in making fences and baskets.

<sup>1</sup> Doolittle, Justus. *Social Life of the Chinese*, 1866, p. 43; revised edition by E. P. Hood, 1868, p. 25.

<sup>2</sup> Seeds and Plants Imported during the Period from December, 1905, to July, 1906. Bulletin 106, Bureau of Plant Industry. U. S. Dept. of Agriculture, 1907, p. 60.



After his return from Manchuria Mr. Meyer prepared for the writer the following statement concerning the use to which the kaoliang is put by the Chinese:

Of the many crops the Chinese grow in North China, the sorghum is unmistakably the most important and the most useful. Without it life in a great part of North China and Manchuria would be almost impossible, for the variety of uses to which the kaoliang is put are legion, and it could not very well be replaced by any other single crop.

The light-colored varieties are ground into flour, out of which cakes are made, or they are simply boiled in water and served in the form of a gruel to the Chinese laborers,



FIG. 6.—Basket made of kaoliang stalks, containing giant red radishes, outside the city wall of Changli, Chihli, China, October 15, 1907. (Photographed by Frank N. Meyer.)

and it is amazing to see how much a Chinese can eat of it. I have seen my own interpreter eat three big bowlfuls for breakfast in the early morning and still feel comfortable. The dark-colored seeds are considered coarser and are used for distilling purposes and as fodder for horses and cattle. Nearly all of the fiery spirits that are used in North China (the so-called samshu) are distilled from these seeds, which are carted about the country in amazing quantities. As a feed for horses and mules one certainly can say that the kaoliang seeds, especially the dark-colored ones, in North China and Manchuria, take the same place that oats do with us.

The stalks of kaoliang are almost as valuable to the Chinese as the grain itself. In the semiarid north, where all of the wild, arboreal vegetation has either been exterminated, or at least has been reduced to such an extent as not to form an important item any longer, one finds that the stalks are the chief supply of fuel. They are used to cook the food, to heat the brick bedsteads in winter time, to boil the water for

tea; in fact, are used whenever heat is needed. Another important rôle they play is in the fine fencing material they furnish. In North China, in winter time, the icy wind blows with great violence all over the plains. To protect themselves, at the approach of the cold season the Chinese build fences around their houses, yards, pigpens, etc., and comfort would certainly be still more reduced in North China if these kaoliang-stem windbreaks were unobtainable.

These stalks are used also as supports for plants in the vegetable gardens. They serve as poles for beans, cucumbers, and yams. [See fig. 7.] They also lend themselves to basket and matting making, and in Shantung I even observed highly colored varieties that were grown for the express purpose of furnishing fancy basket and matting materials. In making the finer qualities of baskets the outer skin only is



FIG. 7.—Kaoliang stalks used as poles to support a yam, *Dioscorea* sp., Changtchon, Chihli, China, October 2, 1907. (Photographed by Frank N. Meyer.)

used, being split off by hand and woven into the various articles desired by skilled men and women. For large, coarse baskets, however, the whole stems are taken while they are still fresh, for when once dry they can not be manipulated very well.

Still another use the Chinese have for these stems is to chop them up, mix them with a few handfuls of boiled black soy beans, or kaoliang seeds, or bean cake, and serve them to their hard-working horses, mules, and donkeys—in the greater part of North China about the only food the draft animals ever get.

One would think by this time that the list of uses for the stems was pretty nearly exhausted, but there are still a few more; for instance, when an ordinary Chinese laborer builds himself a home he first erects a frame of poplar and willow poles; between these he places kaoliang stems. The whole frame is then smeared over with mud, in



which chopped-up straw or hairs has been mixed, and the house is then ready to move into. In the primitive greenhouses of the Chinese these sorghum stems serve as bars to hold the paper windows. They also constitute the frame of the roof, upon which the clay is smeared.

There are several minor uses yet for these stems, such as frames for kites, paper animals, playthings for children, etc., but I am afraid that the list would be too long to add here.

A last item about the kaoliang: Even the roots are not allowed to stay in the ground, but are carefully grubbed out by a stroke of a peculiar hoe or grub and a pull with one hand, are dried, stacked up in bundles, and sold and used all over the land for fuel. One certainly might ask, what would the farmer of North China do if he had no kaoliang to fall back upon.

In the "Report of an Investigation of the Scientific and Economic Relations of the Sorghum Sugar Industry," made by a special committee of the National Academy of Sciences, are given some notes on the uses of kaoliang, contributed by Dr. S. Wells Williams,<sup>1</sup> professor of oriental languages at Yale University. Like nearly all writers previous to the last few years, he confuses the sorgho grown locally on and near Tsungming Island, Chekiang, with the kaoliangs grown generally throughout northern China. The uses he mentions are for the kaoliang plant, except perhaps the reference to the practice of chewing the stems. His statements regarding its uses are as follows:

The Chinese are abundantly supplied with good and cheap sugar in all portions of their empire, coming from the sugar canes of the south; they have, consequently, no need of other sources than this plant. Their uses for sorghum are various—fodder for cattle from its leaves, fuel, wattles for fences, etc., from the stalks. In binding several of these together and cementing with clay they get a cheap substitute for posts, while the stalks in many ways take the place of timber.

Many varieties of the grain, black, red, and white, are known to the farmer. Its seeds, which are abundant, are used for making a sort of spirits, also occasionally for feeding to horses, mules, and camels.

The plant is almost wholly confined in its cultivation to the provinces north of the Yangtze River and forms in this region one of the principal crops. It is not employed as food for man save in times of famine and great stress. When ripe the grain is about the size of duck shot. \* \* \*

The 20 or more varieties<sup>2</sup> which President Angell brought from China could probably be increased in number if the collection were made from a more extended area.

The uses of this plant for fuel tend to increase attention to the development of its stalk rather than the grain.

The plant often attains a height of 15 or 16 feet. The common practice of stripping off all the leaves within reach upon the growing stalk for feeding cattle increases very materially its woody fiber. Cutting the stems while in their prime of growth and chewing them green, as Southerners do the sugar cane, is not unusual in the North.

Kaoliang becomes less extensively grown as one goes southward in China, but the number of uses to which it is put does not diminish

<sup>1</sup> Williams, S. Wells. On the Sorghum (Kow-liang) of China. Report, National Academy of Sciences, November, 1882, pp. 57-58. 1883.

<sup>2</sup> Collier, Peter. Sorghum. American Agriculturist, vol. 45, 1886, p. 153.

in proportion. Chekiang is the most southern coastal province from which samples have been received. A brown-seeded kaoliang (S. P. I. No. 16792) was obtained with other seeds at Hangchow, in Chekiang, by Vice Consul Frederick D. Cloud in 1905. In sending them, after discussing the mixing of kaoliang seed with soy beans and other forage for horse feed, he says:<sup>1</sup>

Perhaps the "kaoliang" is the most highly prized of all forage plants grown in China. No part of the plant goes to waste. Two or three weeks before the plant matures and the seed is ripe the farmer strips nearly all the blades from the plant, ties them in bundles, allows them to cure in the sun for a few days, and then stacks them away indoors. All through the winter these blades are keenly relished by horses and donkeys. Then the seeds are gathered, combed out, and marketed. Several varieties of alcohol and wines are made from these seeds, and the deadly native drink "sam-shu"—at least one variety of it—is made from "kaoliang" seed. The seed makes excellent food for stock of all kinds. The long stalks are thrown on the thrashing floor, rolled flat by heavy stone rollers, carefully cleaned of all particles of pith, and woven into a great variety of mats and matting, suitable for use on floors, for window shades, or for the roofs of native houses and sheds. These stalks are also extensively used for fuel by the farming class. It is a most valuable crop and may be found throughout all the northern provinces. Not grown much as far south as Hangchow.

As previously noted, Wilson<sup>2</sup> states that in southwestern China, in the provinces of Yunnan and Szechwan, 90 per cent of the seed is used for making wine, being only occasionally employed for food, more particularly in the mountain districts. Several years later, while employed as a collector for the Arnold Arboretum, Jamaica Plain, Mass., he obtained three lots of brown-seeded kaoliang (S. P. I. Nos. 21676-21678) at or near Ichang, in the province of Hupeh. In the notes transmitted with the seed he says:<sup>3</sup>

In this part of the Yangtze Valley the sole use of sorghum (kaoliang) is for making wine and spirits. I can find no record of its being used for food, even by the peasants.

As noted by Rein,<sup>4</sup> Bellows,<sup>5</sup> and Sawano,<sup>6</sup> the chief use of kaoliang in Japan is for a windbreak or border about fields, while forms with longer panicles and shortened rachis are utilized for making brooms. Occasionally it is used for human food, concerning which Sawano says: "The seeds or grains are used generally for a kind of cake or pudding, which we call 'mochi.'"

The different uses tabulated below have been specified by the collectors of the samples of seeds listed by number and by the authors whose names are given. The full text of the notes made by the col-

<sup>1</sup> Seeds and Plants Imported during the Period from December, 1903, to December, 1905. Bulletin 97, Bureau of Plant Industry, U. S. Dept. of Agriculture, 1907, pp. 237-238.

<sup>2</sup> Wilson, E. H., loc. cit.

<sup>3</sup> Seeds and Plants Imported during the Period from July, 1906, to December 31, 1907. Bulletin 132, Bureau of Plant Industry, U. S. Dept. of Agriculture, 1908, p. 175.

<sup>4</sup> Rein, J. J., loc. cit.

<sup>5</sup> Bellows, E. C., op. cit.

<sup>6</sup> Sawano, J., op. cit.

lectors will be found in connection with the descriptions arranged numerically on later pages of this bulletin. It is probable that there are numerous other local uses for the plant which are not recorded in the tabulated list.

TABLE I.—*Classified uses of the kaoliang plant in eastern Asia.*

Material used and nature of use.	Designation of seed samples representing varieties so used.	Citation of other authorities for such use.
Grain:		
Feed.....	S. P. I. Nos. 6004, 16792, 17921, 17922, 21078, 28057-28058.	Meyer, Sammons, Williams.
Food.....	Agrost. No. 1586; S. P. I. Nos. 3863, 6406, 6411, 6604, 6710, 17920, 17922, 17923, 21077, 21078.	Doolittle, Meyer, Sammons.
Liquor.....	S. P. I. Nos. 3863, 4905, 6604, 16792, 21676-21678.	Doolittle, Meyer, Sammons, Williams, Wilson.
Heads:		
Brooms.....	Agrost. No. 1585; S. P. I. Nos. 18613, 20627, 22012.	Rein, Sammons.
Fuel.....		Sammons.
Leaves:		
Fodder.....	S. P. I. Nos. 3863, 16792, 17923, 28057-28058.	Meyer, Sammons, Williams.
Mats.....		Sammons.
Roots:		
Fuel.....	S. P. I. No. 17923.....	Meyer, Sammons.
Stalk:		
Baskets.....	S. P. I. No. 17921.....	Meyer (fig. 6). Sammons.
Bridges.....		Meyer, Sammons, Williams.
Building.....	S. P. I. No. 17921.....	Doolittle, Meyer (fig. 5), Sammons, Williams.
Fences and hedges.....	S. P. I. Nos. 3863, 17921.....	Meyer. Doolittle, Meyer, Sammons, Williams.
Fodder.....	S. P. I. Nos. 3863, 16792, 17921, 28057-28058.	Doolittle, Meyer, Sammons, Williams.
Fuel.....		Meyer. Doolittle, Meyer.
Kite frames.....		Meyer, Sammons.
Lath.....		Meyer.
Matting.....	S. P. I. Nos. 16792, 17921, 22011 (red).....	Williams.
Playthings.....		Sammons.
Posts.....		Meyer (fig. 7). Meyer.
Sugar.....	Agrost. No. 1584.....	
Thatching.....	S. P. I. Nos. 16792, 17921.....	
Tying material.....	S. P. I. No. 17921.....	
Trellis.....		
Window frames.....		
Window shades.....	S. P. I. No. 16792.....	
Whole plant:		
Alkali-resistant crop.....	S. P. I. Nos. 18610-18612, 19187, 22012...	
Windbreak.....	Agrost. Nos. 1576, 1586.....	Meyer, Rein.

## KAOLIANGS IN THE UNITED STATES.

## INTRODUCTION OF VARIETIES.

It is possible that seeds of kaoliang varieties were sent to this country previous to 1860, but no record of such introduction has come to the attention of the writer. At various times from 1793 to 1861, kaoliangs had been noted by English diplomatic officers and others<sup>1</sup> as growing abundantly along the Pei from Taku to considerably above Tientsin in Chihli. There is no indication, however, of any attempts to introduce this crop into western lands.

<sup>1</sup> Bretschneider, Emil. History of European Botanical Discoveries in China, vol. 1, 1898, pp. 157-158, 226, 513.

Fortune, Robert. A Narrative of a Journey to the Capitals of Japan and China, 1863, pp. 316, 346.



## HISTORY OF EARLY INTRODUCTIONS.

In 1865 Mr. Varnum D. Collins was sent to China to study the methods supposedly used by the Chinese in making sirup and sugar from sorgo.<sup>1</sup> He was also commissioned to get additional sorgo varieties for use in sugar-making experiments in the United States. In the paper cited he makes no reference to the sending of any seeds of kaoliangs to this country. From other sources, however, we know that four lots of seeds were received from him and that some of them



FIG. 8.—Plants of Brown kaoliang varieties, Arlington Experimental Farm, Va., September 22, 1903: *a*, Meyer Brown (Agrost. No. 1454, S. P. I. No. 6411), from Chosen (Korea); *b*, Baird Brush (Agrost. No. 1453, S. P. I. No. 6406), from Chosen (Korea); *c*, Hansen Brown (Agrost. No. 1448, S. P. I. No. 3803), from China; *d*, Hansen Brown (Agrost. No. 1444), "Red" from California experiment station.

were kaoliangs.<sup>2</sup> These were probably sent after his paper was written. There is no record of what became of them and it is probable that when the stems were found lacking in saccharine juice they were discarded without even so much as having been described. They constitute the first recorded introduction of kaoliangs into the United States.

<sup>1</sup> Collins, Varnum D., loc. cit., p. 91; Clough, William J., *Sorgo Journal* (editorial), vol. 7, 4869, p. 91; Williams, S. Wells, Report, National Academy of Sciences, 1882, p. 57, 1883.

<sup>2</sup> Clough, loc. cit.



Dr. Peter Collier, formerly chemist of the Department of Agriculture, states <sup>1</sup> that in 1881 he received, through President Angell, minister to China, six varieties of sorghum seed, the names of which were as follows:

Hwong-mao-nien-liang—Yellow-cap-glutinous-millet.  
 San-sui-hung-liang—Separated-headstalks-red-millet.  
 San-sui-pai-liang—Separated-headstalks-white-millet.  
 Er-chiu-hung-liang—Second-autumn-red-millet.  
 Ma-wei-nien-liang—Horse-tail-glutinous-millet.  
 Ta-min-hung-liang—Large-people's-red-millet.

The third and fourth varieties are depicted in plates 3 and 4 of Collier's work. Apparently they represent, respectively, a white-seeded sort with large, loose panicles, similar to S. P. I. No. 17920, and a brown-seeded variety with small and very compact panicles resembling S. P. I. No. 18518.

These six varieties, which came from Peking, were grown by Dr. Collier at Washington, D. C., in 1882, with many other varieties from other countries. That they were all true kaoliangs is evident from his comparison <sup>2</sup> of them chemically with saccharine varieties from other sources. He states, further, that all except the first of these Chinese sorts belong to his fifth class; that is, they produce a single stalk from each seed, with no suckers from the roots but with branches at every joint of the parent stalk. The first variety produced sometimes two main stalks from a seed and sometimes a single stalk, and later produced suckers from the roots.

Several references <sup>3</sup> have also been found to 20 varieties of non-saccharine sorghum said to have been received from President Angell, who had obtained them in and about Peking. From an article by Dr. Collier <sup>4</sup> it appears that these 20 lots did not represent a later shipment, but that the 6 lots of seed previously discussed were found, on growing them, to represent 20 different forms.

A few years after the testing of the varieties obtained in China by President Angell, the Kansas Agricultural Experiment Station <sup>5</sup> grew and reported on three varieties in 1890. They were obtained through Consul B. F. Franklin at Hankow, which is in Hupeh Province and is also the source of S. P. I. Nos. 4905 and 6604.

These three varieties were described quite carefully, except that in the case of two of them the seeds are recorded as varying from

<sup>1</sup> Collier, Peter. *Sorghum: Its Culture and Manufacture*, 1884, pls. 3 and 4, p. 76.

<sup>2</sup> Collier, op. cit., pp. 101-107, 535-537.

<sup>3</sup> Williams, S. Wells. *On the Sorghum (Kaoliang) of China*. Report, National Academy of Sciences, 1882, p. 58 [1883]; also quoted by Collier, op. cit., p. 52.

Denton, A. A., and Crampton, C. A. Report on Sorghum Experiments at Sterling, Kans. Bulletin 20, Bureau of Chemistry, U. S. Department of Agriculture, 1889, p. 112.

<sup>4</sup> Collier, Peter. *Sorghum*. *American Agriculturist*, vol. 45, 1886, p. 153.

<sup>5</sup> Georgeson, C. C. Experiments with Forage Plants. Bulletin 18, Kansas Agricultural Experiment Station, 1890, pp. 182-183.

white to red and, in one case, even to black, all in the same head. The apparent mixture of white and colored seeds in the same head is probably due to the well-known bleaching of the yellowish ovary just before the appearance of the pigment which gives the final color to the seed. There is no later record showing the final disposition of these three varieties and it is probable that they were discarded in favor of the kafirs, just then being introduced into cultivation.

#### RECENT INTRODUCTIONS AND THEIR SOURCES.

The official introduction of kaoliang varieties into the United States by the United States Department of Agriculture began with the receipt of S. P. I. No. 225 from North China in the year 1898. Between that time and the close of the year 1910 a total of 51 direct and 3 indirect introductions from eastern Asia had been made.

All varieties obtained or distributed directly by the Office of Foreign Seed and Plant Introduction of the Bureau of Plant Industry are given serial numbers called S. P. I. numbers. When such varieties are tested by the other offices of the Bureau interested in various crops, they are usually given a second number by the office testing them. The two offices which have tested kaoliangs are the former Division of Agrostology and the present Office of Grain Investigations. The writer has had charge of the study of these varieties in both offices.

In Table II these different kinds of numbers are arranged serially in parallel columns. The numbers in column 1 are those applied to a few of the earlier introductions by the Division of Agrostology. The numbers in column 2 are those given by the Office of Grain Investigations. Column 3 contains the original introduction numbers given by the Office of Foreign Seed and Plant Introduction so far as the varieties were obtained by that office. In order to maintain the serial arrangement it has been necessary to enter certain numbers twice. In such cases one entry is not in its proper numerical sequence and is therefore placed in parentheses. Where more than one S. P. I. number is found opposite a G. I. number it indicates that successive crops of improved seed grown in this country have been given new S. P. I. numbers to facilitate the records of distribution. Where an S. P. I. number has no parallel G. I. number it means that that introduction was not grown by the Office of Grain Investigations. In the single case where a G. I. number has no parallel S. P. I. number, viz, G. I. No. 28, it represents an independent accession, similar to those made by the former Division of Agrostology. This table shows also the source of the original seed and the variety of the kaoliang group to which it belongs.

TABLE II.—*List of numbers assigned to kaoliangs by the Division of Agrostology, by the Office of Grain Investigations, and by the Office of Foreign Seed and Plant Introduction, with varietal name and source of original seed.*

Agrost. No.	G. I. No.	S. P. I. No.	Varietal name.	Source.
		225.	Hansen Brown	North China.
		939.	Manchu Brown	Trans-Baikalia, Siberia.
1442.			Brill Blackhull.	California Experiment Station.
1443.			Mukden White	Do.
1444.			Hansen Brown	Do.
1448.		3863.	do	China.
1450.		4905.	Tokyo Brown	Hupeh, China.
1453.		6406.	Baird Brush	Chosen (Korea).
1454.		6411.	Meyer Brown	Do.
1455.	(326).	6604.	Hansen Brown, Hankow Brown	Hupeh, China.
1457.		6710.	Brill Blackhull.	Chihli, China.
1576.			Tokyo Brown.	Honshu, Japan.
1584.			Paperhull.	Do.
1585.			Hoki Brown	Do.
1586.			Tokyo Brown.	Do.
	28.		(Unnamed) Brown	China.
	(152).	16792.	Valley Brown.	Chekiang, China.
	120.	17920.	Brill Blackhull.	Chihli, China.
	121.	17921.	Hansen Brown.	Do.
	122.	17922 (24990)	Peesan Brown	Do.
	123.	17923 (24991)	Tientsin Brown.	Do.
	152.	(16792)	Valley Brown.	Chekiang, China.
		(24992)		
	171.	18518	Manchu Brown	Manchuria.
		(24993)		
		(24994)		
	190.	18610.	Mukden White	Chihli, China.
	191.	18611.	Manchu Brown	Do.
	192.	18612.	do	Do.
		18613.	Headlands Brush	Do.
		18614.	Korean Brush	Do.
		18625.	Meyer Brown	Do.
		18626.	Chihli Brush	Do.
	193.	19187.	Kali Brown	Shengking, Manchuria.
	261.	20612 (24995)	Manchu Brown	Manchuria.
	262.	20620.	do	Usuri, Siberia.
	263.	20621.	Paperhull.	Do.
	264.	20627.	Manchu Brown	Manchuria.
	265.	20706.	Korean Brush (?)	Usuri, Siberia.
	272.	21077.	Mukden White	Shengking, Manchuria.
	273.	21078.	Valley Brown.	Do.
	276.	21676.	Ichang Brown	Hupeh, China.
	277.	21677.	Tokyo Brown.	Do.
	278.	21678.	Shasi Brown	Do.
	293.	22010.	Shantung Dwarf.	Shantung, China.
	(327).	22011.	Redstem	Do.
		22012.	(Unnamed) Brown	Do.
	309.	22911.	Valley Brown.	Kiangsu, China.
	310.	22912.	Barchet Blackhull.	Do.
	323.	23230.	Chusan Brown	Chekiang, China.
	324.	23231.	do	Do.
	326.	(6604, Kan. 595)	Hankow Brown.	Kansas, U. S. A.
	327.	(22011)	Redstem	Shantung, China.
	328.	24478.	Manchu Brown	Kirin, Manchuria.
	(122)	24990.	Peesan Brown	Texas, U. S. A.
	(123)	24991.	Tientsin Brown	Do.
		(24992)		
	(171)	24993	Manchu Brown	Do.
		(24994)		
	(261)	24995	do	Do.
	412.	27553.	Korean Blackhull.	Chosen.
	413.	27554.	Choonchun Brown	Do.
	414.	27555.	Moose Brown	Do.
	421.	28027.	Ware Brown	Kiangsu, China.
	423.	28057.	Valley Brown.	Shengking, Manchuria.
	424.	28058.	Parker Brown.	Do.

Table III shows the localities from which these varieties of kaoliang have been introduced. These localities are grouped by provinces, under the major political division of which they are a part. For each city and town the approximate latitude and longitude are given,



when the place could be found on recent maps. No attempt has been made to indicate the position more closely than by the approximate parallel and meridian.

As stated previously, it is not known whether the sample obtained in Siberia at 51° north latitude was grown there or was imported from some point in Manchuria having a more southern latitude.

TABLE III.—*Localities from which seeds of kaoliangs have been introduced, with the approximate latitude and longitude.*

Division.	Province.	Locality.	Position.	
			Latitude, N.	Longitude, E.
			<i>Degrees.</i>	<i>Degrees.</i>
Siberia.....	{Trans-Baikalia.....	Nertchinsk.....	51	120
	{Usuri.....	(Vladivostok.....	43	132
		(Not designated).....	43-50	132-140
Japan.....	Honshu.....	Tokyo.....	36	140
		Yokohama.....	36	140
Chosen (Korea).....		Choonchun.....		
		Pingyang.....	39	126
Manchuria.....	{Kirin.....	Harbin.....	46	127
	{Shengking.....	Mukden.....	42	123
		Newchwang.....	41	122
		Kungkitschwang.....	40	116
	Chihli.....	Peking.....	40	116
		Peesan.....		
China.....		Shanhaikwan.....	40	120
		Tientsin.....	39	117
		Tsou.....	35	117
	Shantung.....	Chungdun.....	37	117
		Chingshan.....	37	118
	Kiangsu.....	Tsungming Island.....	32	122
		Hankow.....	30	114
	Hupeh.....	Ichang.....	31	112
		Wuchang.....	30	114
	Chekiang.....	Chusan Islands.....	30	122
		Hangchow.....	30	120

#### TESTING THE INTRODUCTIONS.

Some of the earlier introductions by the Office of Foreign Seed and Plant Introduction, as well as several lots obtained independently by the writer, were tested several years ago from the standpoint of forage production. Since it was immediately evident that the fodder was of little value they were mostly discarded after being grown but a single season. These early tests were made at the Arlington Experimental Farm of the Bureau of Plant Industry, at Arlington, Va., and many of them were duplicated at the State experiment stations at Knoxville, Tenn., Baton Rouge, La., and Hays, Kans. The writer wishes to express here his thanks to the directors of these stations and to the officers in charge of the experimental plats for their courteous and helpful cooperation in these tests. Thanks are also due to the Office of Forage-Crop Investigations, and especially to Mr. A. B. Conner, superintendent of the forage experiment station at Chilli-cothe, Tex., for assistance in cooperative varietal tests at that point.

Since the beginning of the year 1906 nearly all kaoliang introductions have been tested from the standpoint of grain production by the Office of Grain Investigations. As soon as an introduction has been received and given an accession (S. P. I.) number by the Office of Foreign Seed and Plant Introduction, the seed is transmitted to the writer for a test of its varietal and agronomic characters. After receiving a Grain Investigations (G. I.) number, a sample sufficient for a hundredth-acre nursery row is sent to the Amarillo experiment farm, which is the chief breeding station of the Office of Grain Investigations for grain sorghums. This farm is located only 2 miles from the town of Amarillo, in the Panhandle of Texas. The elevation is 3,600 feet, the average annual precipitation about 21 inches, the summer temperatures high, the humidity low, and evaporation rapid. These conditions are severe enough to quickly indicate undesirable sorts. The season is short enough to put varieties having early or medium maturity at a premium and yet long enough to permit a varietal study of later maturing forms.

If there is reason to believe, in advance of a test, that the introduction is especially early, the original seed is also tested the first season at one or two points in the North, such as the Bellefourche and Highmore experiment farms in South Dakota, but otherwise the preliminary test is confined to the Amarillo form.

The nursery row, grown from the original seed, is the basis of selection for future tests. If the crop proves early, with a satisfactory habit of growth and a desirable type of head, a considerable number of heads are selected for growing in head rows the following season at other points. If, as more commonly happens, the variety proves late, or of too tall a growth, or with an undesirable type of head, or a mixture of two or more forms, a limited number of heads are selected to be grown in head rows again the following season at the Amarillo experiment farm. Since the kaoliangs are likely to have a limited field of usefulness in this country, all selections are made looking toward the increase of the characters necessary to adapt the crop to the desired conditions.

These characters briefly are earliness, dwarf to medium stature, and compact to semicompact heads, well exerted and well filled. Such selection often quickly alters the nature of the variety so much along these lines that a description of the average plant from the original seed will scarcely fit the improved crop of two or three seasons later.

Table IV shows the varieties that have been under experiment during the period from 1906 to 1911, inclusive, in which the writer has been engaged in the study of sorghums from the standpoint of grain production. It will be seen that 35 introductions have been

studied during the period. Of this number 10 have been discarded as undesirable, about 15 are yet on probation, and about 10 are considered as fixed types of agronomic value. Five of this last group have already been distributed to cooperating farmers, one of the oldest selections (No. 171) in considerable quantity.

TABLE IV.—*Years in which recent kaoliang introductions have been tested at the experiment farm at Amarillo, Tex.*

G. I. No.	S. P. I. No.	Years grown.						G. I. No.	S. P. I. No.	Years grown.					
120	17920	1906	1907	1908	1909	1910	1911	277	21677						1911
121	17921	1906	1907	.....	.....	.....	.....	278	21678	.....	.....	.....	.....	.....	1911
122	17922	1906	1907	1908	1909	1910	1911	293	22010	.....	.....	1908	1909	1910	1911
123	17923	1906	1907	1908	1909	1910	1911	309	22911	.....	.....	1908	1909	1910	1911
152	16792	1906	.....	.....	.....	.....	.....	310	22912	.....	.....	1908	1909	1910	1911
171	18518	1906	1907	1908	1909	1910	1911	323	23230	.....	.....	.....	1909	.....	.....
190	18610	.....	1907	1908	1909	1910	1911	324	23231	.....	.....	.....	1909	1910	1911
191	18611	.....	1907	1908	.....	.....	.....	326	6604	.....	.....	.....	1909	1910	1911
192	18612	.....	1907	1908	.....	.....	.....	327	22011	.....	.....	.....	1909	1910	1911
193	19187	.....	1907	1908	1909	1910	1911	328	24478	.....	.....	.....	1909	1910	1911
261	20612	.....	1907	1908	1909	1910	1911	350	27764	.....	.....	.....	1909	1910	1911
262	20620	.....	<sup>1</sup> 1907	.....	.....	.....	.....	412	27553	.....	.....	.....	.....	1910	1911
263	20621	.....	1907	1908	.....	.....	.....	413	27554	.....	.....	.....	.....	1910	1911
264	20627	.....	<sup>1</sup> 1907	.....	.....	.....	.....	414	27555	.....	.....	.....	.....	1910	1911
265	20706	.....	1907	1908	.....	.....	.....	421	28027	.....	.....	.....	.....	1913	1911
272	21077	.....	1907	1908	1909	1910	1911	423	28057	.....	.....	.....	.....	1910	1911
273	21078	.....	1907	1908	.....	.....	.....	424	28058	.....	.....	.....	.....	1910	1911
276	21676	.....	.....	.....	.....	.....	1911								

<sup>1</sup> Did not germinate.

#### DESCRIPTIVE LIST OF INTRODUCTIONS.

The following list includes all official introductions of kaoliangs by the United States Department of Agriculture, with a single exception, so far as they are known to the writer. The exception noted is G. I. No. 28, the seed of which did not germinate. The list contains also those home-grown selections, from original introductions, which have been given new numbers. The six lots represented by Nos. 24990 to 24995 are examples of such renumberings of improved strains.

The first seven numbers described are those received independently and accessioned by the former Division of Agrostology. Then follow in numerical sequence the numerous introductions and accessions by the Office of Foreign Seed and Plant Introduction, 52 in all, making a total of 59 separate lots described. The 27 varieties herein described include 58 of the 59 lots. A single introduction, S. P. I. No. 22012, remains unidentified for lack of sufficient data.

The varieties proposed herein must be understood in the broad sense in most cases. They are group varieties rather than races or strains. From most of them it is possible to isolate strains sufficiently distinct from each other to be worthy of separate names when grown several years and fully described.



It is probable that most of the major group varieties have now been obtained and studied. Many minor forms doubtless exist in China and Chosen (Korea), which have not yet been introduced into this country. They will probably all be found to come within the limits of the group as here outlined. Most of them are likely also to fall into the group varieties as hereafter described under the classification of the kaoliangs.

In characterizing the different introductions little mention has been made of the leaves or of the awns on the lemmas or flowering glumes. The leaves are small compared with those of kafirs or of most sorgos and are more comparable in size to those of Amber sorgo and the milos. In general, the leaves are proportionate to the size and height of the culm and present no distinctive features. The same is true of the awns, which are universally present.

The terms used in describing the colors of the seeds and glumes are those by Ridgway.<sup>1</sup>

Very few of the many kaoliang introductions have distinctive native names, so far as is indicated by the notes accompanying the seeds. In the few cases where native names are known they are usually too long or too difficult in spelling for use as varietal names. It has therefore been necessary to choose a name for each of the 27 varieties described. The endeavor of the writer has been to apply short and simple names, as was done previously in the case of soy bean varieties,<sup>2</sup> and it is hoped that these names may commend themselves to agronomists and crop breeders. The second word of the double names, as White, Blackhull, Brown, etc., will doubtless be dropped in the case of varieties which finally become well known.

#### AGROSTOLOGY NUMBERS OF INTRODUCTIONS.

1442. *Brill Blackhull*. Received as "Blackhull White kaoliang," by Mr. Ball, from the California experiment station (No. 142-1900) in 1902; grown at the Arlington Experimental Farm in 1903. Plants 7 to 10 feet high, slender, heading in 95 days when sown May 20, and bearing large, lax, oval-oblong panicles 10 to 14 inches in length; spikelets 5.5 mm. long; seeds white, narrowly oval, 4.5 to 5 mm. long by 3 to 3.5 mm. wide, three-fourths inclosed by shining black glumes. Some plants bore panicles somewhat umbelliform, with longer drooping branches. There was also an admixture of a brown kaoliang with more compact and oblong panicles.

1443. *Mukden White*. Received as "White glutinous kaoliang" from the same source as No. 1442. Grown at the Arlington farm in 1903, only a few seeds germinating; plants 8 to 9 feet tall, heading in 94 days from seed sown on May 20; panicles lax, ovate pyramidal, 10 to 12 inches long; spikelets 4 to 6 mm. long, broadly oval; seeds 4 to 5 mm. by 3 to 3.5 mm. wide, oval or obovate oval, white, about one-third exerted; glumes 3 to 4 mm. long, firm, buff to orange buff and orange vermilion.

<sup>1</sup> Ridgway, Robert. A Nomenclature of Colors for Naturalists, 1886, 129 pp., 17 pls.

<sup>2</sup> Ball, Carleton R. Soy Bean Varieties. Bulletin 98, Bureau of Plant Industry, U.S. Dept. of Agriculture, 1907, 30 pp., 5 pls. (Of 23 varieties described in this paper, names were made outright for 18 and simplified for 3 of the remaining 5.—C. R. B.)

1444. *Hansen Brown* (fig. 8, a). Received as "Red kaoliang" from the same source as No. 1442. Grown at Arlington farm in 1903, producing heads in 90 days on plants 10 feet high, bearing large, lax, oval panicles 12 to 14 inches long; spikelets 4.5 to 5.5 mm. long; seeds 4 to 5 mm. long by 3 to 4 mm. wide, obovate or oval, burnt sienna to cinnamon and buff; glumes black, shining, 4 to 4.5 mm. long.

1576. *Tokyo Brown*. Received from Hon. E. C. Bellows, consul general, Yokohama, Japan, on March 6, 1903, with the following note:

I have the honor to transmit a package of Japanese sorghum seed, of the kind known as *morokoshi-kibi*. Messrs. L. Boehmer & Co., horticulturists, of Yokohama, who have furnished this seed without charge, inform me that this sorghum "is of very little importance in Japan, being generally planted along the borders of fields only, in order to protect the field crops against winds, etc. In some parts of the country where rice and other cereals do not grow, sorghum is, to a certain extent, cultivated as a field crop. It is sown in April in seed beds and later transplanted at intervals of 8 or 10 inches." (*Bellows.*)

Grown at Arlington farm in 1903; plants very slender, 5 to 7 feet in height, producing heads in 95 days; panicles ovate pyramidal or somewhat oval, heavy, 6 to 11 inches long; spikelets 3.5 to 4.5 mm. long; seeds 3 to 4.2 mm. by 2.8 to 3.8 mm. wide, from broadly obovate to nearly lenticular; chestnut to burnt sienna; glumes clay to vinaceous cinnamon and maroon, somewhat gibbous at the base, transversely shouldered above the middle, the apex strongly depressed, closely appressed to the seed.

1584. *Paperhull*. Received from Dr. J. Sawano, imperial experiment station, Tokyo, Japan, April 23, 1903, accompanied by the following memorandum:

*Andropogon sorghum* Brot. var. *saccharatus* Koern. Japanese name, *sato-morokoshi* or *rozoku*. This plant was introduced into this country from China about 28 years ago. For many years we tried to prepare sugar from it in many localities, but with poor success, on account of climatic and other circumstances. At the present time it was difficult to obtain even the small quantity sent. (*Sawano.*)

Grown at Arlington farm in 1903; plants 5 to 6 feet tall with very slender stalks, producing heads in 92 days when sown May 27; panicles ovate conical, slender, 6 to 10 inches long, often one-sided and hence right-angled triangular by the bending of the peduncle; spikelets 4.5 to 5.5 mm. long; glumes black or occasionally maroon, thin, papery, equaling the seeds; seeds 3 to 4.5 mm. by 2.5 to 3.5 mm. wide, oval, russet.

1585. *Hoki Brown*. Source, the same as No. 1584.

*Andropogon sorghum* Brot. var. *obovatus* Hack. Japanese name, *hoki-morokoshi*. Its cultivation is quite similar to that of *morokoshi* (see No. 1586); cultivated principally for the ears or top part of the plant, from which, after the seeds are thrashed out, we make brooms, so that the name *hoki*, meaning broom, is given to the plant. It is harvested when fairly, but not fully, ripe because when overripe it is too weak or brittle to be used. (*Sawano.*)

Grown at Arlington farm in 1903; sown May 27 it produced heads in 90 days. The description will be found under this variety in the chapter on classification.

1586. *Tokyo Brown*. Source same as for 1584.

*Andropogon sorghum* Brot. var. *vulgare* Hack. Japanese name, *to-kibi*. It is generally planted along the boundary of a farm plat as a wind shelter for another principal summer crop. Its cultivation is very easy, and, indeed, the farmer does not pay much attention to it. In May or June the seeds are sown in one or two rows. It is harvested about October or November, when the heads turn yellowish in color. (*Sawano.*)

Grown at Arlington farm in 1903; plants 6 feet high, producing heads in 90 days when sown May 27 and bearing very heavy, oval panicles, 8 to 11 inches long and 4 to 5 inches wide, frequently one-sided from the bending of the stems; branches spreading or ascending; spikelets broadly obovate, 3 to 4 mm. in length; glumes brick red to maroon, otherwise as in No. 1576; seeds 3 to 4 mm. long by 2.5 to 3.7 mm. wide, broadly obovate to nearly lenticular, chestnut to blackish at the apices.



## FOREIGN SEED AND PLANT INTRODUCTION NUMBERS.

225. *Hansen Brown*. Received from North China from Prof. N. E. Hansen in March, 1898. "*Ga-oo-lan*, used for human food." Not grown by the writer and no record of its habit on file; spikelets 4 to 5.2 mm. in length; glumes black, shining; seeds 3.5 to 5 mm. long by 2.5 to 3.5 mm. wide, obovate oval, exserted about one-fourth their length, walnut brown to burnt umber.

939. *Manchu Brown*. Received from Nertchinsk, Siberia, through Prof. N. E. Hansen, May 24, 1898; collected by Mr. Roborovsky. Not grown by the writer, but grown by Mr. J. E. Payne at Cheyenne Wells, Colo., in 1900. He notes that when planted April 27 it matured earlier than Early Amber sorgo; spikelets 4.5 to 5 mm. long; glumes black, shining, 3 mm. long; seeds 4 to 4.5 mm. by 3 to 4 mm., obovate oval to sublenticular, chocolate or walnut brown to buff, exserted nearly one-half.

3863 (Agrost. No. 1448). *Hansen Brown* (fig. 8, b). Received from China through Dr. H. W. Wiley, Chief of the Division of Chemistry, September, 1899.

"*Kao liang*."—From 10 to 15 feet in height; growth similar to corn; stalk used for fuel and hedges; leaves stripped for fodder; grain extensively used for food and in the manufacture of alcohol.

Grown at Arlington farm in 1903; plants 10 feet in height, very late, heading in 100 days, ripening in 140 days; panicles large, lax, oblong oval or sometimes closely ovate, 12 to 14 inches long; spikelets 4.5 to 5.5 or 6 mm. long; glumes black, shining, 4 to 5 mm. long; seeds 3.5 to 5 mm. by 2.5 to 3 mm., obovate oval, bay to walnut brown.

4905 (Agrost. No. 1450). *Tokyo Brown*. Received from Wuchang, Hupeh, China. Presented by Messrs. G. D. Brill and J. W. Gilmore.

*Loh goa liang* (No. 38). This is a nonsaccharine sorghum. There are two or three kinds, but the main use of all is for making a kind of whisky. (*Gilmore*.)

Grown at Arlington, Va., Knoxville, Tenn., and Baton Rouge, La., in 1903. No germination obtained at Arlington and very poor germination elsewhere. Plants 1.5 to 1.8 meters (5 to 6 feet) in height, stooling freely; panicles oval, lax, large, 2.5 to 3.5 dm. (10 to 14 inches) long, the branches 1.5 dm. (6 inches) long and drooping, the apex of the panicle often nodding; spikelets 2.3 to 4 mm. long, almost spherical; glumes coriaceous, gibbous at the base, transversely ridged above the center, the apex strongly depressed and closely appressed to the seed, mostly cream buff shaded to heliotrope, to burnt sienna and claret; seeds 2.5 to 3.5 mm. by 2.5 to 3 mm., very broadly obovate or mostly sublenticular, clay to dark clay or darker, nearly included.

6406 (Agrost. No. 1453). *Baird Brush* (fig. 8, c). Received from Pyeng Yang (Ping-yang), Chosen (Korea), May 3, 1901. Presented by Rev. W. M. Baird.

A kind of grain similar in appearance to broom corn or sugar cane. The seeds are eaten. The canes are very straight and quite useful. Planted in May. (*Baird*.)

Grown at Arlington, Va., in 1903. Plants 1.8 to 2.7 meters (6 to 9 feet) in height; panicles slender, light colored, umbelliform, 3 to 5 dm. (12 to 20 inches) long, the apex nodding from the weight of seed; spikelets 4.5 to 6 mm. long; glumes shining, clay to tawny; seeds 4 to 5 mm. by 3 to 3.5 mm., oval, flattened, one-fourth exserted, clay to russet. A tall and medium-late variety, ripening in 120 days after planting.

6411 (Agrost. No. 1454). *Meyer Brown* (fig. 8, d). Source of seed same as for No. 6406.

Kind of grain similar in appearance to broom corn and sugar cane. The grain is eaten by Koreans. The canes are straight and valuable. (*Baird*.)

Grown at Arlington, Va., in 1903. Plants 1.8 to 2.4 meters (6 to 8 feet) in height, rather slender; panicles large, heavy, compact or semicompact, 1.5 to 2.5 dm. (6 to 10

inches), mostly one-sided from the leaning of the stalks and peduncle, dark red from the large and well-exserted seeds; spikelets 4 to 5.5 mm.; glumes black, shining; seeds 3.5 to 5 mm. long by 2 to 4 mm. wide, oval or obovate oval, a few sublenticular, exerted one-fourth to one-third, russet to walnut and chocolate. A variety of medium height and medium early in maturity, ripening in 120 days.

6604 (Agrost. No. 1455; also G. I. No. 326 selected from Kansas experiment station No. 595, which was grown from original seed of S. P. I. No. 6604). Hansen Brown in part; Hankow Brown in part (Pl. II, I). Received from Hankow, China, under the name "Barbados millet," May 17, 1901. Presented by Mr. G. D. Brill.

Grown at Arlington, Va., Knoxville, Tenn., Baton Rouge, La., and Hays, Kans., in 1903. It proved to be a decided mixture, containing the tall, late variety Hansen Brown, 2.4 to 3 meters (8 to 10 feet) in height, stout, with large leaves and large ovate or conical panicles, some lax, some more dense. It contained also one early strain of medium height which, without doubt, is the one later designated as G. I. No. 326. In 1903 the writer was concerned only with forage-producing varieties and this one was no longer grown. In 1908, however, when engaged in the study of grain-producing sorghums, he obtained from the Kansas experiment station a sample of their No. 595, which was designated as G. I. No. 326. This was ascertained to have been produced from S. P. I. No. 6604 and quite certainly represents the early strain noted in 1903. This Kansas strain was grown at Amarillo, Tex., in 1909 and may be described as follows: Plants 1.5 to 1.8 meters (5 to 6 feet) in height; panicles oval oblong, 2 to 2.7 dm. (8 to 11 inches) in length, some compact with continued rachis and also branches 6 to 10 cm. long, often naked for more than half their length; spikelets 3 to 4.5 mm. long; glumes mostly black and shining; seeds 3 to 4 mm. long by 2 to 5.3 mm. wide, obovate to broadly obovate or sublenticular, cream to burnt sienna, scarcely exerted. An early variety, maturing in 95 to 100 days from planting.

6710 (Agrost. No. 1457). *Brill Blackhull*. Received from Peking, China, June 12, 1901, through Mr. G. D. Brill (No. 156).

"This is much grown for human food around Peking and is considered much superior to the other varieties." (*Brill*.)

Grown at Arlington, Va., and Baton Rouge, La., in 1903. No germination was obtained at the former place and only three or four seeds grew at the latter. Plants 2.4 to 2.7 meters (8 to 9 feet) in height, suckering abundantly by reason of the thin stand; heads oval, lax, large, 2.5 to 3.5 dm. (10 to 14 inches) long, 2 to 2.5 dm. (8 to 10 inches) in width. Spikelets 4.5 to 6 mm. long; glumes black, shining; seeds narrowly oval to oval, 4 to 5.5 mm. long by 3 to 4 mm. wide, white. A tall and late variety, maturing in 120 to 140 days.

16792 (G. I. No. 152). *Valley Brown*. Received from Hangchow, China, December 15, 1905, through Mr. Frederick D. Cloud, American vice consul.

This bean (Black soy, No. 16796) mixed with "kaoliang" (sorghum) seed, chopped grass, or straw, with a little bran, makes the very best horse feed. Perhaps the "kaoliang" is the most highly prized of all forage plants grown in China. No part of the plant goes to waste. Two or three weeks before the plant matures and the seed is ripe the farmer strips nearly all the blades from the plant, ties them in bundles, allows them to cure in the sun for a few days, and then stacks them away indoors. All through the winter these blades are keenly relished by horses and donkeys. Then the seeds are gathered, combed out, and marketed. Several varieties of alcohol and wines are made from these seeds, and the deadly native drink "sam-shu"—at least one variety of it—is made from "kaoliang" seed. The seed makes excellent food for stock of all kinds. The long stalks are thrown on the thrashing floor, rolled flat by heavy stone rollers, carefully cleaned of all particles of pith, and woven into a great variety of mats and matting, suitable for use on floors, for window shades, or for the roofs of native houses and sheds. These stalks are also extensively used for fuel by the farming class. It is a most valuable crop and may be found throughout all the northern provinces. Not grown much as far south as Hangchow. (*Cloud*.)

Grown at Chillicothe and San Antonio, Tex., in 1906. Plants 2.1 to 3 meters (7 to 10 feet) in height, 1.5 to 2 cm. in diameter at the butt, producing 1 to 3 suckers and bearing 9 to 13 leaves, 5 to 7 cm. (2 to 3 inches) wide and 6 to 7.5 dm. (2 to 2.5 feet) long; panicles broadly oval or occasionally ovate, large, 2 to 3.5 dm. (8 to 14 inches) long, 1 to 2 dm. (4 to 8 inches) wide; spikelets obovate, 4 to 5.5 mm. long; glumes 3.5 to 4.5 mm. long, buff to tawny or claret brown; seeds 3.5 to 5 mm. long by 2.5 to 4 mm. wide, obovate oval, chestnut to russet and buff. The original introduction contained a mixture of varieties and some hybrids. The principal variety, to which the name is applied, is of medium height and medium-early maturity, ripening in 100 to 105 days.

17920 (G. I. No. 120). *Brill Blackhull* (Pl. II, A). Received from Peesan, China, February 23, 1906, through Mr. Frank N. Meyer, Agricultural Explorer, Bureau of Plant Industry.

This variety has white seeds and is used for making bread; as such it is more highly esteemed than the brown-colored varieties, which are generally only used as fodder for the domestic animals. (*Meyer.*)

Grown in varietal test at Amarillo, Chillicothe, and San Antonio, Tex., in 1906. Plants 2.1 to 3.6 meters (7 to 12 feet) in height, partly proportionate to locality, producing 1 to 3 suckers and bearing 10 to 15 leaves each 6 to 7.5 cm. (2.5 to 3 inches) wide and 6 to 7.5 dm. (2 to 2.5 feet) in length; panicles broadly oval, lax, heavy (weighing 3 ounces each), 2.2 to 3.5 dm. (9 to 14 inches) long and 1 to 1.5 dm. (4 to 6 inches) wide, large, much-branched, the lower branches 1.2 to 2.5 dm. (5 to 10 inches) long, flexuous at the base, equaling the rachis, or one-half to seven-tenths as long as the panicle; spikelets obovate oval, 6 to 7 mm. long; glumes black, shining, 3 to 4.5 mm. long; seeds oval or narrowly oval, white, 4 to 6 mm. long by 3 to 3.5 mm. wide, one-third exserted; anthers pale yellow and stigmas white at San Antonio. A tall, late-maturing variety, ripening seed in 120 to 135 days from planting.

17921 (G. I. No. 121). *Hansen Brown* (fig. 9, left; Pl. II, E). Source the same as for No. 17920.

(No. 22, a.) A variety with dark-brown seeds, universally used throughout North China as fodder for domestic animals. The stems of sorghum are used in building houses, the stalks being embedded in the mud walls; also for making fences, baskets, mats, tying and roofing material, and for fuel. (*Meyer.*)

Grown in varietal test at Amarillo, Chillicothe, and San Antonio, Tex., in 1906. Plants 2.1 to 3 meters (7 to 10 feet) in height, 1.5 to 2 mm. (0.5 to 0.7 inch) in butt diameter; suckers, 1 to 3; leaves, 10 to 13, 5 to 8 cm. (2 to 3 inches) wide, 6 to 7.5 dm. (2 to 2.5 feet) in length; panicles broadly oval, semicompact to lax, 2 to 3 dm. (8 to 12 inches) long and 1 to 2 dm. (4 to 8 inches) wide; spikelets 5.5 to 6 mm. long; glumes black, shining, 4 mm. long; seeds 4.5 to 5.5 mm. long by 3.5 to 4.5 mm. wide, bay to cinnamon, one-half exserted. A tall and late variety, maturing in 125 to 140 days.

17922 (G. I. No. 122). *Peesan Brown* (Pl. II, N). Source the same as for No. 17920.

(No. 23, a.) A variety with light-brown seeds, not very much grown. It is used where found as a fodder plant and also for making a brown-colored kind of bread. (*Meyer.*)

Grown in varietal test at Amarillo, Chillicothe, and San Antonio, Tex., in 1906, and at different points continuously thereafter. Plants 2 to 2.4 meters (6.5 to 8 feet) in height; suckers, 1 to 3; leaves, 9 to 11, 5 to 7 cm. (2 to 2.6 inches) wide, 4.5 to 6 dm. (1.5 to 2 feet) in length; panicles erect, well exserted, ovate conical or frequently one-sided by the bending of the peduncle, 1.5 to 2.8 dm. (6 to 11 inches)



long, 1 to 1.5 dm. (4 to 6 inches) wide; spikelets oval, 4 to 5.5 mm. long; glumes 3.5 to 4.5 mm. long, clay to madder brown; seeds 3.5 to 5 mm. long by 3 to 4 mm. wide, mostly oval or some broadly obovate, russet to bay in the original sample, becoming cream buff to raw sienna and hazel in later years. A variety of medium-late maturity, ripening in 115 to 125 days. The strain under selection, G. I. No. 122, is about 5.5 feet in height and matures in 110 to 115 days.

17923 (G. I. No. 123); 24991. *Tientsin Brown* (fig. 9, right; Pl. II, *F*). Received from Tientsin, Chihli, China, through Mr. F. N. Meyer, February 23, 1906.



FIG. 9.—Plants of two brown kaoliang varieties, Hansen Brown (G. I. No. 121, S. P. I. No. 17921), and Tienstin Brown (G. I. No. 123, S. P. I. No. 17923), grown from original seed at Chillicothe, Tex., September 6, 1906. (Photographed by C. R. Ball.)

(No. 151, *a*.) A superior variety of sorghum which grows from 15 to 20 feet in height. The grain is ground, and from the flour a good kind of bread is made; is used also for the same purpose as the one described under No. 22, *a* (S. P. I. No. 17921). In addition to this the leaves are pulled off before they have turned brown, when they make an excellent cattle food, either fresh or dry. The roots are also dug and used as fuel. (*Meyer*.)

Grown in varietal test at Amarillo, Chillicothe, and San Antonio, Tex., in 1906, and at various points in 1907. A variety of medium height and maturity, ripening in 105 to 120 days. The large heads are not well filled at the base. It differs from Hansen Brown chiefly in being earlier. A description will be found under this variety in the classification.

18518 (G. I. No. 171); also 24992, 24993, and 24994. *Manchu Brown* (fig. 10; Pl. II, *H*). Received from Manchuria through the Yokohama Nursery Co., Yokohama, Japan, May 9, 1906.

*Kaulien* sorghum of Manchuria, which forms the staple produce of that country and which has been made famous in the last year. It grows 8 to 10 feet high; the stalks and grain were indispensable for all concerned. (*Yokohama Nursery Co.*)

Grown in varietal test at Amarillo, Chillicothe, and San Antonio, Tex., in 1906, at various points in 1907, and in our regular field experiments each year thereafter. Plants low, 1.4 to 1.8 meters (4.5 to 6 feet) in height, .6 to 1 cm. (.25 to .40 of an inch) in butt diameter; suckers 1 to 3; leaves 7 to 9, small, 4 to 6 cm. (1.5 to 2.5 inches)

wide, 3 to 4.5 dm. (1 to 1.5 feet) long; panicle well exerted, oval, 2 to 2.5 dm. (8 to 10 inches) long, the lower branches 5 to 10 cm. (2 to 4 inches) in length; rachis continuous; spikelets 4.5 to 6 mm. long; glumes black, shining; seeds obovate oval to oval, 4 to 5.5 mm. long by 3 to 4 mm. wide, walnut brown to burnt sienna or madder brown where exposed, and white to buff and russet where included in the glumes, one-third exerted; anthers and stigmas yellow. A low, early, and valuable variety, ripening in 90 to 100 days. Widely distributed to cooperating farmers at higher elevations in the central Plains area.

18610 (G. I. No. 190). *Mukden White* (fig. 11; Pl. II, D). Received from Shanghai-kwan, Chihli, China, at the Plant Introduction Garden, Chico, Cal., from Mr. F. N. Meyer, May 18, 1906.

(No. 153, a.) A white-grained variety of sorghum grown on rather alkaline land. (*Meyer.*)

Grown at Amarillo and Chillicothe, Tex., Modesto, Cal., and North Platte, Nebr., in 1907. Plants 1.5 to 2.4 meters (5 to 8 feet) in height, rather stout, 1.2 to 2.5 cm.



FIG. 10.—Field of Manchu Brown kaoliang (G. I. No. 171, S. P. I. No. 18518), 5 feet tall, Amarillo, Tex., August 20, 1908. (Photographed by C. R. Ball.)

(0.5 to 1 inch) in butt diameter, mostly without suckers; leaves 8 to 11; panicles oval or ovate, rather heavy, 2 to 2.7 dm. (8 to 11 inches) in length, basal branches 1 to 1.5 (4 to 6 inches) long; spikelets broadly oval, 5 to 6 mm. long; glumes 3 to 4 mm. long, buff, shading strongly to orange buff and orange vermillion; seeds obovate oval, 4 to 5 mm. long by 3 to 3.5 mm. wide, white, one-third exerted. A medium-tall variety, medium early to medium late in maturity, ripening in 105 to 115 days. One early head was noted as having deciduous spikelets, an unusual character which belongs to the wild species *Andropogon halepensis* Brot.



18611 (G. I. No. 191). *Manchu Brown*. Source same as for 18610.

(154. a.) A light-brown colored variety of sorghum grown on rather alkaline land. (*Meyer*.)

Grown in varietal test at Amarillo and Chillicothe, Tex., Modesto, Cal., and North Platte, Nebr., in 1907. Plants 1.5 to 2.1 meters (5 to 7 feet) in height, slender to stout; panicle small, oval, rather compact, 1.5 to 2.2 dm. (6 to 9 inches) in length, the lower branches 5 to 10 cm. (2 to 4 inches) long, the rachis five-sixths as long as the panicle; spikelets 4 to 5.5 mm. long; glumes black, shining; seeds obovate to broadly

obovate oval, 3.5 to 5 mm. long by 3 to 4 mm. wide, burnt sienna to cinnamon rufous to buff. A low to medium variety with small panicles, ripening in 100 to 105 days.

18612 (G. I. No. 192). *Manchu Brown*. Source the same as for No. 18610.

(155. a.) A dark-brown colored variety of sorghum grown on rather alkaline land. (*Meyer*.)

Grown at Amarillo and Chillicothe, Tex., Modesto, Cal., and North Platte, Nebr., in 1907. Plants slender, 1.5 to 2.1 meters (5 to 7 feet) in height; panicles medium size, light weight, lax, 2 to 2.7 dm. (8 to 11 inches) long; spikelets oval, 5 to 6 mm. long; glumes black, shining; seeds narrowly oval to oval or obovate, 4 to 6 mm. long, 2.5 to 4 mm. wide, russet to burnt umber and bay, one-third exerted. A low to medium variety, of medium early maturity, ripening in 100 to 105 days.

18613. *Headlands Brush*. Received from Peking, China, at the Plant Introduction Garden, Chico, Cal., through Mr. F. N. Meyer, May 18, 1906.



FIG. 11.—Plants of Mukden White kaoliang (G. I. No. 190, S. P. I. No. 18610), Amarillo, Tex., October 5, 1908. (Photographed by C. R. Ball.)

(No. 172, a.) White seeded. Given to me by Mr. J. T. Headlands, of the Methodist Mission, Peking. This is the drooping variety used to make brooms from. (*Meyer*.)

Grown at Chico, Cal., in 1906, but no record of its habit available. Planted at Chillicothe, Tex., in 1907, but the seed did not germinate. A description of the original panicle will be found under this variety in the classification.

18614. *Baird Brush*. Source the same as for 18613. "(No. 172, a.) Brown seeded." Grown at Chico, Cal., in 1906, but no record is available. Grown at Chillicothe, Tex., in 1907. Plants slender, 2.4 meters (8 feet) in height; panicles subumbelliform, 3 to 3.7 dm. (12 to 15 inches) in length, lower branches 1.2 to 2 dm. (5 to 8 inches) long, and the rachis one-half to three-fourths as long as the panicle; spikelets 4.5 to 6 mm. long; glumes 4 to 5 mm. long, buff-yellow to burnt sienna; seeds obovate, obovate oval, or oval, 4 to 5.5 mm. long by 3 to 3.5 mm. wide, buff yellow and burnt sienna to bay, one-fifth to one-fourth exserted. A variety of medium height and of medium late maturity.

18625. *Meyer Brown*. Received from Kungkitschang, Chihli, China, at the Plant Introduction Garden, Chico, Cal., through Mr. F. N. Meyer, May 18, 1906. "(No. 171, a.) Red seeded."

Grown at Chico, Cal., in 1906, but no record available. Grown at Chillicothe, Tex., in 1907. Plants 2.4 meters (8 feet) in height; panicles sparse and rather slender, 2.5 to 3 dm. (10 to 12 inches) in length, the lower branches 5 to 12 cm. (2 to 5 inches) long, and the rachis two-thirds as long as, to equaling, the panicle; spikelets oval, 4.5 to 6 mm. long; glumes seal brown or black; seeds oval or obovate, 4 to 5.5 mm. long by 2.8 to 3.8 mm. wide, russet to bay. A variety of medium height and medium-late maturity, ripening in 115 days.

18626. *Chihli Brush*. Source the same as for 18625. "(No. 171, a.) White seeded."

Grown at Chico, Cal., in 1906, but no record available. Grown at Chillicothe, Tex., in 1907. A description will be found under this variety in the classification.

19187 (G. I. No. 193). *Kali Brown* (Pl. II, G). Received from Newchwang, Manchuria, through Mr. F. N. Meyer, August 28, 1906.

(No. 259, a) Chinese name, *kauliang*. A brown-colored variety of sorghum, said to be grown on the rather alkaline lands around Newchwang. (Meyer.)

Grown in varietal test at Amarillo and Chillicothe, Tex., Hays, Kans., North Platte, Nebr., Highmore, S. Dak., and Modesto, Cal., in 1907. A description will be found under this variety in the classification. A low to medium variety, early to medium early in maturity, ripening in 100 to 110 days. Differs from Manchu Brown chiefly in greater height and later maturity. Name suggested by its reported use on alkaline soils.

20612 (G. I. No. 261); also 24995. *Manchu Brown* (fig. 12). Received from Manchuria through Prof. N. E. Hansen, Agricultural Explorer, March, 1907.

(No. 92) *Gaolan*. Brought by a Russian student-soldier from Manchuria after the Russo-Japanese War. (Hansen.)

Grown at Amarillo, Tex., in 1907. Plants slender, 1.2 to 1.8 meters (4 to 6 feet) in height; leaves small, 7 to 10; panicles small to medium, sparse, of light weight, narrowly ovate or conical, 1.5 to 2.5 dm. (6 to 10 inches) in length, the lower branches 5 to 10 cm. (2 to 4 inches) long; spikelets 5 to 6 mm. long; glumes black, shining; seeds oval or obovate oval, 4 to 5.5 mm. long by 3 to 4 mm. wide, burnt umber to raw umber to buff, one-fourth exserted. A low and extra-early variety, maturing in 85 to 95 days, the earliest of any introduction yet tested. It is proving of value in extending the cultivation of this crop to South Dakota and other Northern and Northwestern States.

20620 (G. I. No. 262). *Manchu Brown* (?). Received from Usuri Province, Siberia, through Prof. N. E. Hansen, Agricultural Explorer, March, 1907.

(No. 100) *Gaolan*. This variety grows from 20 to 25 feet in height, and during the Russo-Japanese war the Cossacks on horseback found trouble in getting through the sorghum fields, as they would be lost from view even with their spears. (Hansen.)



Planted at Amarillo, Tex., in 1907, but no seed germinated. Plant not known and identification doubtful; spikelets 4 to 5.5 mm.; glumes chestnut to maroon, shining; seeds obovate or obovate oval, 4.5 mm. long by 3 to 3.8 mm. wide, walnut brown to bay.

20621 (G. I. No. 263). *Paperhull*. Source same as for No. 20620.

(No. 101) *Gaolan*. For description see No. 100 (S. P. I. No. 20620). The head does not appear as compact as in No. 100. Seed brought from Manchuria by a Russian student-soldier after the Russo-Japanese war. (*Hansen*.)

Grown at Amarillo, Tex., in 1907, and again in 1908. Plants 1.5 to 2 meters (5 to 6.5 feet) in height; leaves 6 to 8; panicle ovate or ovate conical, sparse, lax, of light weight; spikelets 4.5 to 5.5 mm. long; glumes thin, papery, black, shining, equaling the seed; seeds narrowly oval, 4 to 5 mm. long by 2.5 to 3 mm. wide, burnt umber,



FIG. 12.—Field of an extra-early variety of Manchhu Brown kaoliang (G. I. No. 261, S. P. I. No. 20612), Amarillo, Tex., August 20, 1908. (Photographed by C. R. Ball.)

included. A low variety of extra-early to early maturity, ripening in 85 to 95 days; heads, however, of poor quality and the variety discarded.

20627 (G. I. No. 264). *Manchu Brown*(?). Source same as for No. 20612.

(No. 107) Native name, *Tjie-choo-meed-zha*. This variety is used for brooms in Manchuria. Seed brought from Manchuria by a Russian student-soldier after the Russo-Japanese war. (*Hansen*.)

Planted at Amarillo, Tex., in 1907, but no seed germinated. Plant not known and identification doubtful; spikelets 4.5 to 5.5 mm. long; glumes maroon to black with buff trimmings; seeds obovate oval, 4 to 4.5 mm. long by 3 to 3.5 mm. wide, walnut brown to chocolate.



20706 (G. I. No. 265). *Baird Brush* (?). Received from the southern part of the Pacific coast section of Usuri Province, Siberia, through Prof. N. E. Hansen, Agricultural Explorer, March, 1907.

"(No. 186) *Gaolan*." (*Hansen*.)

Grown at Amarillo, Tex., in 1907, when only a single seed germinated, and again in 1908. Plant 1.5 to 1.8 meters (5 to 6 feet) in height; leaves 7 to 8; panicles narrowly ovate or conical, small, lax, poorer than those of No. 20621 and much inferior to those of No. 20612; the very immature original sample has spikelets 4.5 to 5 mm. long; glumes buff to coral to madder brown; seeds too shrunken for accurate measurement; apparently no home-grown samples preserved. A low and early variety, ripening in 85 to 95 days; of no value.

21077 (G. I. No. 272). *Mukden White* (see fig. 14, *d*). Received from Mukden, Manchuria, through Mr. Frank N. Meyer, June 21, 1907.

(No. 717, *a*, January 23, 1907.) A white sorghum; Chinese name, *Pai kau liang*. The best variety of white millet grown around Mukden. It is used as a food in the form of porridge, small cakes, and also served often as vermicelli. It commands one-third more money than the brown-colored millets do. (*Meyer*.)

Grown at Chillicothe, Tex., in 1907, and at Amarillo, Tex., Hays, Kans., Akron, Colo., Bellefourche, S. Dak., and Dickinson, N. Dak., in 1908. Plants 1.8 to 2.4 meters (6 to 8 feet) in height; leaves 9 to 11; panicles large, oval to conical, lax, 2.2 to 3 dm. (9 to 12 inches) in length; spikelets oval, 4 to 5 mm. long; glumes 3 to 4 mm. long, mostly buff, rarely shaded; seeds oval to obovate oval, 4 to 4.5 mm. long by 3 to 3.5 mm. wide, one-fourth to one-third exserted. A variety of medium height and of medium-early to medium-late maturity, ripening in 95 to 115 days; panicles less desirable than those of No. 17920.

21078 (G. I. No. 273). *Valley Brown* (fig. 14, *a*). Source same as for No. 21077.

(No. 718, *a*, January 23, 1907.) A brown-colored sorghum; Chinese name *kau liang*. The best variety of brown millet grown around Mukden. It is used as a food in the shape of porridge and cakes; also an important food for the domestic animals. (*Meyer*.)

The record for this introduction is a duplicate of that for No. 21077. They were introduced, distributed, and tested together and gave identical results, the chief difference apparent in the field being in the color of the seeds; spikelets 4.5 to 5.7 mm. long; glumes buff to burnt sienna; seeds oval, broadly oval or obovate, 3.5 to 5.2 mm. long by 2.5 to 3.5 mm. wide, clay to burnt sienna, one-fourth exserted.

21676 (G. I. No. 276). *Ichang Brown*. Received from Ichang, Hupeh, China, through Mr. E. H. Wilson, collector for the Arnold Arboretum, Jamaica Plain, Mass., in November and December, 1907.

(No. 260.) A cereal growing 6 to 12 feet high. Pellicles reddish black. Cultivated in the valleys and low hills to the south of Ichang. (*Wilson*.)

Grown at Amarillo, Tex., in 1911. A description will be found in the classification. A variety of medium height and medium maturity, ripening in 110 days in the season tested.

The original sample contained some smaller spikelets with glumes gibbous at the base and transversely ridged, orange vermilion in color, apparently the same as those comprising most of No. 21677. When grown, the resulting plants were essentially Tokyo Brown, the variety represented by the above number, which is discussed below.

21677 (G. I. No. 277). *Tokyo Brown* (Pl. II, *P*). The source is the same as for No. 21676.

(No. 260, *a*.) A cereal growing 6 to 12 feet high. Pellicles black or nearly so. Commonly cultivated in the valleys around Ichang. (*Wilson*.)

Grown at Amarillo, Tex., in 1911. Plants 1.3 to 1.7 meters (4.5 to 5.5 feet) in height, with stout culms, 2.2 to 2.7 cm. (0.9 to 1.2 inches) in butt diameter; leaves 11 to 12 in number, 0.85 to 1 dm. (3.5 to 4 inches) wide, 7.5 to 8.1 dm. (2.5 to 2.7 feet) long; panicles large, conical, lax, 3 to 3.7 dm. (12 to 15 inches) in length, exserted 5 cm. (2 inches) or less, lower branches 1 to 2 dm. (4 to 8 inches) long; spikelets small, broadly ovate, 3 mm. wide in one plane, 4 mm. wide in the other, and 4 mm. long; glumes gibbous at the base, transversely shouldered above the center, apex depressed and appressed to the seed, cinnamon, cream, and clay to claret brown and black; seeds broadly obovate to sublenticular, 3 to 3.5 mm. wide by 4 mm. long, russet to burnt umber in the original seed, cream to raw sienna and burnt sienna in the Amarillo seed. A low variety of medium maturity, ripening in 110 days in the single test so far made. The original was a mixture of two varieties, the one described below and one with normal glumes, practically identical with Tokyo Brown, G. I. No. 276, from the same source.

21678 (G. I. No. 278). *Shasi Brown* (Pl. II, *M*). Source same as for No. 21676.

(No. 202.) A cereal growing 8 to 12 feet high. Pellicles dull red or reddish chestnut. Widely cultivated on the alluvial flats between Shasi and Yochow, and more especially around Shasi. It was from the last-named place that the seeds were obtained. In this part of the Yangtze Valley the sole use of sorghum (kaoliang) is for making wine and spirits. I can find no record of its being used for food even, by the peasants. (*Wilson*.)

Grown at Amarillo, Tex., in 1911. A description will be found in the chapter on classification. A variety of medium stature and maturity, ripening in 110 days in the single test made.

22010 (G. I. No. 293). *Shantung Dwarf* (fig. 13; fig. 14, *b*; Pl. II, *R*). Received from Chingshan, Shantung, China, at the Plant Introduction Garden, Chico, Cal., through Mr. Frank N. Meyer, February 12, 1908.

(No. 810, *a*, August 12, 1907.) Chinese name, *Chi tse ya tse*. A very rare dwarf variety of sorghum, not growing higher than 3 feet and making dense heads. Grows on shallow sterile soils and matures much earlier than the taller growing varieties. May do well in the semiarid regions of the western United States. (*Meyer*.)

Grown at Amarillo, Tex., in 1908, and continuously there and at other points thereafter. Description will be found under this variety in the classification. A very dwarf variety of medium-early maturity, ripening in 105 to 110 days.

22011 (G. I. No. 327). *Redstem*. Received from near Chufoo (Tsou<sup>1</sup>), Shantung, China, at the Plant Introduction Garden, Chico, Cal., through Mr. Frank N. Meyer, February 12, 1908.

(No. 811, *a*, September 7, 1907.) A red-stemmed variety used in the manufacture of matings, of which pretty specimens may be seen once in a while. (*Meyer*.)

Grown at Chico, Cal., in 1908, but no record is available. Grown at Amarillo, Tex., in 1909, and thereafter. A description will be found under this variety in the classification. A low to medium variety of early maturity, ripening in about 95 days; strikingly characterized by the reddish stems.

22012. Variety not determined. Received from near Chungdun, Shantung, China; otherwise same as No. 22010.

(No. 812, *a*, September 29, 1907.) A very tall-growing loose-headed variety of sorghum. The thrashed-out heads are utilized in broom manufacture. Stands alkali well. (*Meyer*.)

Not grown by the writer and a description of the plant is not available; panicle sparse, lax, narrowly ovate conical, 4 dm. (16 inches) in length, somewhat resembling

<sup>1</sup> Mr. S. C. Stuntz, of the Office of Foreign Seed and Plant Introduction, identifies the Chufoo of Mr. Meyer's notes as Tsou, the suffix "foo" or "fu" merely denoting a town of certain official rank.



that of Minnesota Amber sorgo; branches 1.5 to 2 dm. (6 to 8 inches) long; rachis continuous; spikelets obovate oval, 5 to 5.5 mm. long; glumes 4.5 to 5 mm. long, subglaucous, smoke gray or heliotrope; seeds oval, 4.5 to 5 mm. long by 3 to 3.5 mm. wide, clay to burnt umber.

22911 (G. I. No. 309). *Valley Brown* (fig. 14, c; Pl. II, J.). From Tsungming Island, China. Obtained through Rev. J. Ware and presented by Dr. S. P. Barchet, interpreter, American consulate, Shanghai, China. Received May 20, 1908.

Grown at Amarillo, Tex., in 1908. Plant 1.8 meters (6 feet) in height and stoutish, 2 to 2.5 cm. (1 inch) in butt diameter; leaves 8 to 10 in number, 7.5 to 8.5 dm. (3 to 3.5 inches) wide, 6 to 6.5 dm. (2 to 2.2 feet) long; panicles oval, lax, heavy, 2 to 3 dm. (8 to 12 inches) long and 1 to 2 dm. (4 to 8 inches) wide, well exerted; spikelets 4 to 5.5



FIG. 13.—Plants of Shantung Dwarf Brown kaoliang (G. I. No. 293, S. P. I. No. 22010) in the foreground and the ordinary taller variety behind it, Chingshan, Shantung, China, August 12, 1907. (Photographed by Frank N. Meyer.)

mm. long; glumes mostly buff or clay, shading to cardinal and maroon; seeds broadly obovate oval to sublenticular or subspherical, being less flattened than most, 3.5 to 5 mm. long by 2.6 to 4 mm. wide, clay to walnut brown in the original sample, cream to russet to burnt umber in later years. A low to medium variety, early to medium-early in maturity, ripening in 100 to 105 days; of considerable promise as a grain producer.

22912 (G. I. No. 310). *Barchet Blackhull* (fig. 15; Pl. II, C). From Tsungming Island, China. Obtained through Rev. J. Ware and presented by Dr. S. P. Barchet, interpreter, American consulate, Shanghai, China. Received May 20, 1908.

The white variety (S. P. I. No. 22912) is considered inferior to the red (S. P. I. No. 22911, Brown), though planted in the same way. It is planted in richly manured



land in rows 6 inches wide covered lightly with half an inch of earth. If plants come up too thick or crowded, the plants which should be removed are not pulled, but cut off with a sharp knife, so as not to disturb the roots of neighboring plants. (*Barchet.*)

Grown at Amarillo, Tex., in 1908, and thereafter. A description will be found under this variety in the classification. A low variety of early to medium-early maturity, ripening in 100 to 105 days; unfortunately allowed to hybridize with a brown-seeded variety in 1908, the crop of 1909 containing 50 per cent or more of hybrids. A pure strain has been isolated and is likely to prove one of the most valuable of the introductions.

23230 (G. I. No. 323). *Chusan Brown*. Received from Chusan Islands, Chekiang, China, through Mr. Frank N. Meyer, Agricultural Explorer, and brought by him to



FIG. 14.—Rows of five varieties of kaoliang, Amarillo, Tex., August 20, 1908: *a*, Valley Brown (G. I. No. 273, S. P. I. No. 21078); *b*, Shantung Dwarf Brown (G. I. No. 293, S. P. I. No. 22010); *c*, Valley Brown (G. I. No. 309, S. P. I. No. 22911); *d*, Mukden White (G. I. No. 272, S. P. I. No. 21077); *e*, Barchet Black-hull (G. I. No. 310, S. P. I. No. 22912.)

the Plant Introduction Garden, Chico, Cal., June, 1908. Forwarded to Washington, D. C., and received July 6, 1908.

(No. 983, *a*, April, 1908.) A tall-growing variety of sorghum, coming from the Chusan Islands, called *Chang tsun*. Obtained from Dr. S. P. Barchet at Shanghai, China. (*Meyer.*)

Grown at Amarillo, Tex., in 1909, where only 13 seeds germinated, each producing two stalks. No description of the plant is available; glumes short, chestnut to bay, shining; seeds broadly ovate or sublenticular, 3 to 4 mm. long by 2.5 to 3.5 mm. wide, chocolate to burnt umber to bay.

23231 (G. I. No. 324). *Chusan Brown* (Pl. II, *O*). Source same as for No. 23230.

(No. 984, *a*, April, 1908.) A dwarfy form of a sorghum, coming from the Chusan Islands, called *Tuan tsun*. Obtained from Dr. S. P. Barchet at Shanghai, China. (*Meyer.*)

Grown at Amarillo, Tex., in 1909, 1910, and 1911, only 54 seeds germinating in the first year. Plants 1.3 to 2 meters (4.5 to 6.5 feet) in height, mostly without suckers; leaves 9 to 11 in number, 0.8 to 1 dm. (3.2 to 4 inches) wide, 6.5 to 7.5 dm. (2.2 to 2.5

feet) long; panicles small, compact, 1.4 to 1.8 dm. (5.5 to 7.5 inches) long; lower branches only 5 to 9 cm. in length, seeded to the base; rachis continuous; spikelets 3.5 to 4 mm. long; glumes brick red to maroon and darker, shining; seeds broadly obovate to sublenticular, 3 to 4 mm. long by 2.8 to 3.2 mm. wide, walnut brown to bay in original sample; clay to raw sienna to bay. A low variety of medium maturity, ripening in about 110 days in 1910 and 1911.



FIG. 15.—Plat of Barchet Blackhull kaoliang (G. I. No. 310, S. P. I. No. 22912), grown at Dalhart, Tex., 1911; height, 4½ feet. (Photographed by C. R. Ball.)

24478 (G. I. No. 328). *Manchu Brown*. Received from Manchuria, through Prof. N. E. Hansen, Agricultural Explorer, December 3, 1908.

(No. 85.) Variety *Gaolan* from the Harbin district, bought in a Chinese bazaar at Station Manchuria, the first station in Chinese territory going east on the Siberian Railway. The favorite variety in northern Manchuria. (Hansen.)

Grown at Amarillo, Tex., in 1909, and thereafter. Plants 1.4 to 1.8 meters (4.5 to 6 feet) in height, with no suckers and an average of 10 leaves; panicles oval, 2 to 2.7 dm. (8 to 11 inches) in length, lower branches 5 to 10 cm. (2 to 4 inches) long, rachis



continuous; spikelets 4.5 to 5 mm. long; glumes black, shining; seeds obovate, oval, or a few broadly obovate, 4 to 5 mm. long by 3 to 3.7 mm. wide, burnt umber with chocolate tips. A low, extra-early to early variety, ripening in 80 to 90 days.

24990 (G. I. No. 122). *Peesan Brown*.

Grown on the experiment farm at Amarillo, Tex., by Mr. John F. Ross, season of 1908. Received March, 1909.

Improved by selection for dwarf stature, productiveness, etc., from S. P. I No. 17922, by Mr. Carleton R. Ball.

24991 (G. I. No. 123). *Tientsin Brown*.

Grown as was No. 24990. Improved at the last by selection from No. 17923.

24992 (G. I. No. 171, A). *Manchu Brown*.

Grown as was No. 24990. Improved at the last by selection from No. 18518.

24993 (G. I. No. 171, B). *Manchu Brown*. Record the same as for No. 24992.

24994 (G. I. No. 171, C). *Manchu Brown*. Record the same as for No. 24992.

24995 (G. I. No. 261). *Manchu Brown*. Grown as was No. 24990.

Improved by Mr. Carleton R. Ball, by selection from No. 20612.

27553 (G. I. No. 412). *Korean Blackhull* (Pl. II, B). Received from Choon Chun, Chosen (Korea) April 4, 1910, through Mr. J. Robert Moose.

Grown at Amarillo, Tex., in 1910 and 1911. A description will be found under this variety in the classification. A tall, medium-early variety with large ovate-conical heads, maturing in 103 and 108 days in the two seasons tested.

27554 (G. I. No. 413). *Choonchun Brown* (Pl. II, Q). Source same as for 27553.

Grown at Amarillo, Tex., in 1910 and 1911. A description will be found under this variety in the classification. A low variety of medium-early maturity, ripening in 103 and 98 days in the two seasons grown; not promising.

27555 (G. I. No. 414). *Moose Brown*. Source same as for 27553.

Grown at Amarillo, Tex., in 1910 and 1911. A description will be found in the classification. A variety of medium height and of medium-late maturity, ripening in 114 and 120 days in the two seasons tested.

28027 (G. I. No. 421). *Ware Brown* (Pl. II, K). Received from Tsungming Island, Chekiang, China, May 20, 1910. Secured by Rev. James Ware, of the Foreign Christian Missionary Society, Shanghai, China, and forwarded through Mr. Amos P. Wilder, American consul general.

Kowliang. Said to be the finest variety on the island. Tsungming is an alluvial island in the estuary of the Yangtze River. It lies between 31° and 32° north latitude. Prevailing winds from southeast. Total length from east to west 60 miles; average breadth 12 miles. The soil is rich except at the northwest corner, where it is overcharged with alkali. Population, including small islands around and a few towns on the north mainland, 1,200,000. (*Ware*.)

Grown at Amarillo, Tex., in 1910 and 1911. A description will be found in the classification. A medium-low and early to medium-early variety, ripening in 92 days in 1910 and in 92 to 110 days in 1911.

28057 (G. I. No. 423). *Valley Brown*. Received from Mukden, Manchuria, June 2, 1910. Produced by Mr. Edward C. Parker, agriculturist, Bureau of Agriculture, Industry, and Commerce, Mukden, Manchuria.

High stalk, spreading panicle. Chinese name, *Sungma kaoliang*. This plant is the chief and characteristic crop of Manchuria. Its seeds are the every-day food of most of the common people, as well as the chief food of the farm animals. The leaves are stripped off the plant for live-stock food, and the stalks are burned to boil the water and heat the mud houses for all Manchuria. This sample of seed comes from



Mukden, Manchuria, 42° north latitude, and is of a tall-growing variety with open or spreading panicle. This tall kaoliang thrives best in latitude 38° to 42° north, maturing usually in October and requiring a late autumn to properly mature. It withstands drought and hot, drying winds better than maize and will also stand an excess of moisture better than maize. The stalks are fibrous and rigid and do not lodge under stress as easily as maize. (*Parker.*)

Grown at Amarillo, Tex., in 1910 and 1911. Plants 2.1 to 2.7 meters (7 to 9 feet), slender to medium in diameter; leaves 9 to 10 in number, 0.7 to 0.9 dm. (2.7 to 3.5 inches) wide, 6 to 6.7 dm. (2 to 2.2 feet) long; panicle very lax, oval or subconical or sometimes nearly one-sided, large, 2.5 to 3.5 dm. (10 to 14 inches) in length, exserted 0.7 to 1.5 dm. (3 to 6 inches), with lower branches 1.2 to 2 dm. (5 to 8 inches) long, and upper branches 1 to 1.2 dm. (4 to 5 inches) or longer; the rachis one-half to three-fourths as long as the panicle; spikelets 4.5 to 5 mm. long; glumes buff to clay to hazel to brick red; seeds oval to obovate, 4 to 4.8 mm. long by 3 to 3.5 mm. wide, cream to orange buff, russet and madder brown, in 1910 white, buff, hazel, and brick red, in 1911 buff to chestnut, one-sixth exserted. A medium-early variety of medium height, ripening in 99 and 110 days in the two seasons tested.

28058 (G. I. No. 424). *Parker Brown* (Pl. II, L). Source same as for 28057.

Short stalk, compact panicle. Chinese name, *Chinma kaoliang*. This species matures somewhat earlier than the tall variety (S. P. I. No. 28057) and is grown commonly in Manchuria north of 42° north latitude. This sample comes from Mukden, Manchuria. Usage same as No. 28057. (*Parker.*)

Grown at Amarillo, Tex., in 1910 and 1911. A description will be found in the classification. A variety of medium height and early maturity, ripening in 92 and 96 days in the two seasons tested.

#### CLASSIFICATION OF THE KAOLIANGS.

##### DESCRIPTION OF THE GROUP.

The extensive varietal study which has been conducted with these introductions makes it possible to characterize the group of kaoliangs with some accuracy. From the foregoing descriptions of the various introductions it becomes apparent that there is much diversity of habit, color, etc., among the various varieties. Nevertheless, they have certain characters in common. Among these common characters are dry, pithy, and rather slender stalks, usually only 1 to 3 cm. in butt diameter, bearing relatively few (8 to 11 or sometimes 13) leaves which are comparatively small, 1 to 2.5 feet long and 1 to 2.5 inches wide; glumes never exceeding the seed, almost wholly glabrous, and lemmas always awned.

The rachis and panicle branches are more or less scabrous, but not pubescent except on and around the pulvini or swollen bases of the panicle branches. The sterile spikelets are 3 to 4 mm. long and narrowly lanceolate or elliptical, consisting of the outer glumes. The awn of the lemma is universally present, 2 to 5 mm. long, twisted, and geniculate in the middle.

In habit the kaoliangs vary from 0.7 to 3.6 meters in height, the panicles varying from small, oval, and compact to long, umbelliform,

and lax. The glumes vary from gibbous at the base, transversely ridged above the center with depressed and closely appressed apex to thin, flat, and chartaceous; from one-half or two-thirds as long as the seeds to equaling them; from cream or cream buff through various shades of red and brown to black. The seeds also vary in size from 3 to 6 mm. long; in shape from narrowly oval to sublenticular, and in color from chalky white through buff and orange buff to various shades of reddish brown and brown. So far as known all are susceptible to the kernelsmut (*Sphacelotheca reiliana*). Almost all lots of seed imported are infected with this disease.

It may be contended that the varieties having glumes gibbous at the base, transversely ridged above the center, and the apices depressed and closely appressed to the seed should really be placed in a group separate from the kaoliangs. These glume characters indicate durra affinities and it is probable that their original Indian progenitors were less widely separated from the durras. In the long time, probably centuries, however, which has elapsed since their introduction to China, they have varied in the same directions as the more typical kaoliangs.

Twenty-seven varieties of kaoliang are described in this paper. Five of these are in the white-seeded section of the group and 22 in the section with brown seeds. Of the 5 varieties having white seeds, 3 fall in the subsection having black glumes and 2 in the subsection with buff glumes. Of the 22 varieties in the brown-seeded section, 8 occur in the black-glumed subsection and 14 in that with buff to red glumes. These 27 varieties include 58 of the 59 separate introductions and accessions described. The remaining one is a recent introduction, which is described but not identified for lack of sufficient data.

#### KEY TO THE VARIETIES.

#### I. Seeds white, dirty white, or cream.

##### A. Glumes black, shining.

##### 1. Seeds white, narrowly oval to oval.

- a. Panicles large, lax, oval or subumbelliform, 9 to 14 inches long; plants 8 to 12 feet tall, late.

**Brill Blackhull** [Agrost. No. 1442; S. P. I. Nos. 6710 (Agrost. No. 1457), 17920 (G. I. No. 120)].

##### 2. Seeds dirty white, obovate or sublenticular.

- a. Panicle lax, ovate or ovate conical or one-sided, often nodding, 8 to 12 inches long; plants 6 to 8 feet tall, medium early.

**Korean Blackhull** [S. P. I. No. 27553 (G. I. No. 412)].

- b. Panicle semicompact, oval, 7 to 10 inches, erect; plants 5 to 6 feet, medium early.

**Barchet Blackhull** [S. P. I. No. 22912 (G. I. No. 310)].

## I. Seeds white, dirty white, or cream—Continued.

## B. Glumes buff, often shading to orange buff or orange vermillion.

## 1. Seeds white, oval or obovate oval.

- a. Panicle lax, oval or ovate, large, 8 to 12 inches long; plants 6 to 10 feet tall, medium early.

**Mukden White** [Agrost. No. 1443; S. P. I. Nos. 18610 (G. I. No. 190), 21077 (G. I. No. 272)].

## 2. Seeds cream, obovate to sublenticular.

- a. Panicle lax, elongated, umbelliform, 12 to 15 inches long.

**Headlands Brush** [S. P. I. No. 18613].

## II. Seeds brown or reddish brown.

## A. Glumes black, shining.

## 1. Glumes equaling the seed.

- a. Glumes coriaceous; panicle umbelliform; plants 6 to 8 feet tall, medium late.

**Hoki Brown** [Agrost. No. 1585].

- b. Glumes thin, papery; inflorescence paniculate; plants 5 to 6 feet tall, early.

**Paperhull Brown** [Agrost. No. 1584; S. P. I. No. 20621 (G. I. No. 263)].

## 2. Glumes shorter than the seed.

- a. Seeds medium to large, oval to obovate oval; panicle medium to large, lax, 8 to 14 inches long.

- \* Panicle lax, large, 8 to 14 inches long, broadly oval; plants 7 to 10 feet tall, late in maturity.

**Hansen Brown** [Agrost. No. 1444; S. P. I. Nos. 225, 3863 (Agrost. No. 1448), 6604 (Agrost. No. 1455 in part), 17921 (G. I. No. 121)].

- \*\* Panicle lax, large, coarse, 9 to 14 inches long, oval or obovate oval, naked at base; plants 7 to 8.5 feet tall, medium in maturity (105 to 120 days).

**Tientsin Brown** [S. P. I. Nos. 17923 (G. I. No. 123), 24991].

- \*\*\* Panicle finer, sparse, narrowly oval to cylindrical, 8 to 12 inches long; plant 6 to 8 feet tall, medium-late maturity (115 to 120 days).

**Meyer Brown** [S. P. I. Nos. 6411 (Agrost. No. 1454), 18625].

- \*\*\*\* Panicle small to medium, semicompact, oval, 8 to 10 inches long.

△ Plant 5 to 8 feet tall, medium early, (100 to 110 days).

**Kali Brown** [S. P. I. No. 19187 (G. I. No. 193)].

△△ Plant 4.5 to 7 feet tall, extra early to early (85 to 100 days).

**Manchu Brown** [S. P. I. Nos. 939, 18518 (G. I. No. 171), 18611 (G. I. No. 191), 18612 (G. I. No. 192), 20612 (G. I. No. 261), 20620 (G. I. No. 262), 20627 (G. I. No. 264), 24478 (G. I. No. 328), 24992 to 24994 (G. I. No. 171), 24995 (G. I. No. 261)].

## b. Seeds small, broadly obovate or sublenticular.

- \* Panicle small, slender, oblong, semicompact, 8 to 11 inches long.

**Hankow Brown** [S. P. I. No. 6604 in part (Agrost. No. 1455) (Kans. Exp. Sta. No. 595) (G. I. No. 326)].



## II. Seeds brown or reddish brown—Continued.

## B. Glumes buff to various shades of red.

## 1. Glume I flat, glume II keeled, not gibbous or ridged.

## a. Inflorescence umbelliform, rachis shortened.

\* Panicle medium (9 to 11 inches); branches shorter.

**Chihli Brush** [S. P. I. No. 18626].

\*\* Panicle elongated (12 to 18 inches), branches equaling the panicle.

**Baird Brush** [S. P. I. Nos. 6406 (Agrost. No. 1453), 18614, 20706 (?) (G. I. No. 265)].

## b. Inflorescence paniculate; oval, ovate or conical.

\* Panicle broadly oval, lax, heavy, 2.5 to 3.3 dm. (10 to 14 inches) long; rachis somewhat shortened, upper branches 1 to 1.2 dm. (4 to 5 inches) long, more than half as long as the lower; color effect light brown.

△ Seeds large, broadly obovate or oval to sublenticular; glumes buff to cardinal and maroon.

**Valley Brown** [S. P. I. Nos. 16792 (G. I. No. 152), 21078 (G. I. No. 273), 22911 (G. I. No. 309), 28057 (G. I. No. 423)].

△△ Seeds large, oval to obovate; glumes paler.

**Moose Brown** [S. P. I. No. 27555 (G. I. No. 414)].

\*\* Panicle conical, lax, heavy, 2.5 to 3.5 dm. (10 to 14 inches) long; upper branches 5 to 7 cm. (2 to 2.8 inches) long; rachis nearly equaling panicle.

△ Glumes, especially glume I, exceeding the seed, 5 to 6 mm. long.

**Ware Brown** [S. P. I. No. 28027 (G. I. No. 421)].

△△ Glumes equaling or, especially glume II, shorter than the seed, 4 to 5 mm. long.

+ Peduncles red.

**Redstem** [S. P. I. No. 22011 (G. I. No. 327)].

++ Peduncles straw color.

○ Lower panicle branches 1.2 to 1.6 dm. (5 to 6.5 inches) long.

† Branches stout, rigid; seeds acute.

**Parker Brown** [S. P. I. No. 28058 (G. I. No. 424)].

†† Branches slender, flexible; seeds obtuse.

= Seeds elliptical or narrowly oval.

**Shasi Brown** [S. P. I. No. 21678 (G. I. No. 278)].

== Seeds broadly oval to sublenticular.

**Peesan Brown** [S. P. I. Nos. 17922 (G. I. No. 122); 24990].

○○ Lower panicle branches 0.5 to 1 dm. (2 to 4 inches) long.

**Ichang Brown** [S. P. I. No. 21676 (G. I. No. 276)].

\*\*\* Panicle small, oval, compact, 3 to 6 inches long; seeds small, broadly obovate to sublenticular.

**Chusan Brown** [S. P. I. Nos. 23230 (G. I. No. 323), 23231 (G. I. No. 324)].

## II. Seeds brown or reddish brown—Continued.

## B. Glumes buff to various shades of red—Continued.

2. Glumes gibbous at the base, transversely ridged above the middle, with depressed apex.

a. Spikelets small, broadly obovate to sublenticular; panicle large, lax; plants medium height.

**Tokyo Brown:** [Agrost. Nos. 1576, 1586; S. P. I. Nos. 4905, 21677 (G. I. No. 277)].

b. Spikelets medium to large, oval; panicle small to medium, compact.

\* Plant medium; spikelets medium; panicle small, slender.

**Chounchun Brown** [S. P. I. No. 27554 (G. I. No. 413)].

\*\* Plant very dwarf; panicle heavy, compact, oval; spikelets large.

**Shantung Dwarf** [S. P. I. No. 22010 (G. I. No. 293)].

## DESCRIPTION OF THE VARIETIES.

In the white-seeded section of the kaoliang group five varieties have been distinguished, three in the subsection having black hulls and two in the one having buff hulls. These varieties may be separated and described as follows:

I. *Seeds white, dirty white, or cream.*A. *Glumes black and shining.*1. *Seeds white, narrowly oval to oval.*

**Brill Blackhull.** Agrost. No. 1442; S. P. I. Nos. 6710 (Agrost. No. 1457), 17920 (G. I. No. 120) (Pl. II, A). Plants 2.4 to 3.6 meters (8 to 12 feet) tall, bearing 10 to 13 leaves and 1 to 3 suckers each; panicles large, erect, lax, much branched, not always fully exerted, 2.3 to 3.5 dm. (9 to 14 inches) long, and 1 to 1.5 dm. (4 to 6 inches) wide, with rachis one-half to two-thirds as long as the panicle and about equaling the basal branches; spikelets 5 to 7 mm. long; seeds chalky to dirty white, narrowly oval, 4 to 6 mm. long, 3 to 4 mm. wide, covered for three-fourths of their length by the shining black glumes.

A tall, late variety with large open heads, maturing in 120 to 140 days, too tall and late for profitable use. Continued selection for earliness has given but little result so far. It is comparable to Hansen Brown among the brown varieties.

2. *Seeds dirty white, obovate or sublenticular.*a. *Panicles large, lax, ovate conical, or one-sided.*

**Korean Blackhull.** S. P. I. No. 27553 (G. I. No. 412) (Pl. II, B). Plants 1.8 to 2.4 meters (6 to 8 feet) tall, stoutish, 2.5 to 3 cm. (1 to 1.2 inches) in butt diameter, bearing 10 to 11 leaves; panicle large, lax, ovate conical or one sided, and forming a right-angled triangle, 2.5 to 3.7 dm. (10 to 15 inches) long, often nodding at maturity; lower branches 1.2 to 2.2 dm. (5 to 9 inches) long; spikelets 4 to 4.5 mm. long; seeds 3.5 to 4 mm. long, 3 to 3.5 mm. wide, obovate or sublenticular, dirty white, three-fourths inclosed by the shining black glumes.

A tall medium-early variety with large ovate-conical heads, maturing in 103 and 108 days in the two seasons tested.

b. *Panicles medium size, semicompact, oval.*

**Barchet Blackhull.** S. P. I. No. 22912 (G. I. No. 310) (Pl. II, C; fig. 14, e; fig. 15). Plants 1.3 to 1.6 meters (4.5 to 6 feet) tall, 1.5 to 3 cm. in butt diameter, bearing 8 to 9 leaves; panicle spreading or semicompact, oval or ovate oval, 2 to 2.5 dm. (8 to

10 inches) long, heavy (averaging 3 ounces each), fairly exserted; spikelets 4 to 4.5 mm. long; seeds dirty white, broadly obovate or sublenticular, 3.5 to 4 mm. long, 3 to 3.6 mm. wide, broader in proportion than those of any other white-seeded form; glumes black and shining, covering two-thirds of the seed.

A low, medium-early variety with oval heads, averaging 2 to 2.7 ounces each in different seasons, maturing in 100 days in 1908 and in 105 to 110 in later seasons, classing it as medium early.

*B. Glumes buff, often shading to orange buff or orange vermilion.*

*1. Seeds white, oval or obovate oval.*

*a. Panicles lax, oval or semipyriform, large.*

*Mukden White.* Agrost. No. 1443; S. P. I. Nos. 18610 (G. I. No. 190), 21077 (G. I. No. 272) (Pl. II, *D*; fig. 11; fig. 14, *d*). Plants 1.8 to 3 meters (6 to 10 feet) tall, bearing 9 to 11 leaves and usually no suckers; panicles lax, oval or subconical, large, 2 to 3 dm. (8 to 12 inches) long, with a nearly continuous rachis and the basal branches 1 to 1.5 dm. (4 to 6 inches) long; spikelets 4 to 6 mm. long, broadly oval; seeds 4 to 5 mm. long by 3 to 3.5 mm. wide, oval or obovate oval, white, exserted about one-third of their length; glumes 3 to 4 mm. long, firm, buff to orange buff and orange vermilion.

*2. Seeds cream colored, obovate to sublenticular.*

*a. Panicle lax, elongated, umbelliform.*

*Headlands Brush.* S. P. I. No. 18613. Plant not known; original panicle lax, elongated, umbelliform, 3.2 dm. (13 inches) long, probably nodding, the rachis 8 cm. (3 inches) long, bearing 4 whorls of branches; spikelets 4 to 4.5 mm. long, sublenticular, seeds 3.5 to 4 mm. long, 3 to 3.5 mm. wide, broadly obovate to sublenticular, cream colored; slightly exserted; glumes cream colored, shining, covering four-fifths to all of the seed.

Sixteen varieties are found in the section with brown seeds. Seven of these occur in the subsection having black glumes and 14 in the subsection having the glumes varying from buff to different shades of red.

*II. Seeds brown or reddish brown.*

*A. Glumes black, shining.*

*1. Glumes equaling the seeds.*

*a. Glumes firm; panicle umbelliform, 12 inches long; plants 6 to 8 feet tall, medium late.*

*Hoki Brown.* Agrost. No. 1585. Plants 1.8 to 2.4 meters (6 to 8 feet) tall; panicle umbelliform, slender, 3 dm. (12 inches) long, becoming reflexed and nodding; branches mostly basal, elongated; rachis, however, extended, its first internode several inches long, bearing terminal whorls of short branches from the second and third nodes; spikelets black, obovate, 4.2 to 5 mm. long; glumes black, shining; seeds obovate oval, 3.7 to 4.3 mm. by 2.8 to 3.5 mm., russet to burnt umber.

A broom-corn type of medium height, heading in 90 days, ripening probably in 120 days, and therefore medium late. Possibly a degenerate form of a true broom corn introduced into Japan from Europe or America.

*b. Glumes thin, papery; inflorescence paniculate; plants 5 to 6 feet tall, early.*

*Paperhull.* Agrost. No. 1584; S. P. I. No. 20621 (G. I. No. 263). Plants 1.5 to 2 meters (5 to 6.5 feet) tall, bearing 6 to 8 leaves; panicles sparse, ovate or elliptical, 1.5 to 2.5 dm. (6 to 10 inches) long; spikelets oval, 4.5 to 5.5 mm. long; glumes black,



shining, as long as the seeds, thin, chartaceous or papery in texture; seeds oval or narrowly oval, 4 to 5 mm. by 2.5 to 3 mm., russet to burnt umber.

A rather low variety, extra early to early, maturing in 85 to 95 or 100 days. The name was suggested by the character of the glumes.

2. *Glumes shorter than the seed.*

a. *Seeds medium to large, oval to obovate oval; panicle medium to large, lax, 7 to 14 inches long.*

\* *Panicle lax, large, 8 to 14 inches long, broadly oval; plants 7 to 10 feet tall, late in maturity.*

*Hansen Brown.* Agrost. No. 1444; S. P. I. Nos. 225, 3863, 6604 (in part), 17921 (G. I. No. 121) (Pl. II, E; fig. 8, a, b; fig. 9). Plants tall, stoutish, 2 to 3 meters (7 to 10 feet) high, bearing 9 to 13 leaves and 1 to 3 suckers; panicles lax, broadly oval, 2 to 3.5 dm. (8 to 14 inches) long, 1 to 2 dm. (4 to 8 inches) wide, heavy; spikelets 4 to 5.5 or 6 mm. long; seeds obovate oval, 3.5 to 5.5 mm. long by 3 to 4.5 mm. wide, bay, walnut brown, or cinnamon, bleaching to burnt sienna and buff; glumes shining black, about one-third shorter than the seeds.

A tall, late variety, maturing in 120 to 140 days. Named for Prof. N. E. Hansen, horticulturist of the South Dakota Experiment Station and Agricultural College and agricultural explorer for the United States Department of Agriculture, who sent the seed of S. P. I. No. 225, the earliest official introduction. Comparable to Brill Black-hull among the white-seeded varieties.

\*\* *Panicle lax, large, coarse, 9 to 14 inches long, oval or obovate oval, naked at base; plants 7 to 8.5 feet tall, medium in maturity (105 to 120 days).*

*Tientsin Brown.* S. P. I. Nos. 17923 (G. I. No. 123), 24991 (Pl. II, F; fig. 9). Plants 2 to 2.5 meters (7 to 8.5 feet) tall, stoutish, bearing 10 to 12 leaves; panicles large, lax, much branched, oval, 2.2 to 3.5 dm. (9 to 14 inches) long; basal branches 1 to 1.7 dm. (4 to 7 inches) long, ascending to appressed, commonly naked for half their length; spikelets large, oval, 4 to 6 mm. long; glumes black, or occasionally claret, shining; seeds large, mostly oval, some obovate, 4 to 5.5 mm. long by 3.4 mm. wide, one-third exerted, clay to russet and bay.

A variety of medium height and maturity, ripening in 105 to 120 days. The large heads are not well filled at the base. Differs from Hansen Brown chiefly in being earlier.

\*\*\* *Panicle finer, sparse, narrowly oval to cylindrical, 8 to 12 inches long; plant 6 to 8 feet tall, medium-late maturity (115 to 120 days).*

*Meyer Brown.* S. P. I. Nos. 6411 (Agrost. No. 1454), 18625 (fig. 8, d). Plants 1.8 to 2.4 meters (6 to 8 feet) in height; panicles lax, medium to large, 2 to 3 dm. (8 to 12 inches) long, oval or narrowly oval; lower branches 7 to 12 cm. (2.5 to 5 inches) long; rachis two-thirds as long as to equaling the panicle; spikelets oval, 4.5 to 6 mm. long; glumes shining, mostly black, occasionally seal brown; seeds 3.5 to 5.5 mm. long, 3 to 4 mm. wide, oval or obovate, exerted one-fourth, russet to bay or chocolate. A variety of medium height and medium maturity, ripening in 115 to 120 days.

\*\*\*\* *Panicle small to medium, oval, semicompact, 8 to 10 inches long.*

△ *Plant 5 to 8 feet tall, medium early (100 to 110 days).*

*Kali Brown.* S. P. I. No. 19187 (G. I. No. 193) (Pl. II, G). Plants slender, 1.5 to 2.4 meters (5 to 8 feet) in height; panicles small, rather compact, 1.5 to 2.2 dm. (6 to 8 inches) in length, the lower branches 5 to 10 cm. (2 to 4 inches) long, and the rachis five-eighths to five-sixths as long as the panicle; spikelets 4.5 to 5.5 mm. long; glumes

3 to 4 mm. long, black, shining; seeds obovate oval, 4 to 5 mm. long by 3 to 4 mm. wide; walnut brown or burnt umber or paler. A low to medium variety, early to medium early in maturity, ripening in 100 to 110 days. Differs from Manchu Brown chiefly in greater height and later maturity. Name suggested by its reported use on alkali soils.

△△ *Plant 4.5 to 7 feet tall, extra early to early (85 to 100 days).*

*Manchu Brown.* S. P. I. Nos. 939, 18518 (G. I. No. 171), 18611 (G. I. No. 191), 18612 (G. I. No. 192), 20612 (G. I. No. 261), 20620 (G. I. No. 262), 20627 (G. I. No. 264), 24478 (G. I. No. 328), 24992-24994 (G. I. No. 171), 24995 (G. I. No. 261) (Pl. II, H; fig. 10; fig. 12).

Plants 1.4 to 2 meters (4.5 to 7 feet) in height, slender, bearing 7 to 9 leaves and usually no suckers or only one per plant; panicles oval or narrowly ovate, 2 to 2.7 dm. (8 to 10 or 11 inches) long; spikelets oval, acute, 4.5 to 5.5 or 6 mm. long; glumes black, shining, exposing one-third of the seed; seeds obovate oval to oval, 4 to 5.5 mm. long, 3 to 4 mm. wide, mostly dark brown, as burnt sienna, burnt umber, and chocolate where exposed, and buff to russet where included.

A low to medium variety of Manchurian origin, extra-early to early, maturing in 85 to 105 or 110 days, according to locality and season. The most important variety, agronomically, extending the use of these plants into the Northern States.

b. *Seeds small, broadly obovate or sublenticular.*

\* *Panicle small, slender, semicompact, 8 to 11 inches long.*

*Hankow Brown.* S. P. I. No. 6604 in part (Kans. Exp. Sta. No. 595) (G. I. No. 326) (Pl. II, I). Plants 1.5 to 2.1 meters (5 to 7 feet) in height; stems stoutish, 2.5 to 3 cm. (1 to 1.2 inches) in butt diameter; leaves 9 to 12 in number; panicles slender, oblong, semicompact, 2 to 3 dm. (8 to 12 inches) long; lower branches 6 to 10 cm. (2.5 to 4 inches) long; butts poor to fair; rachis continuous; spikelets 4 to 5 mm. long; seeds 3 to 4 mm. long by 2.5 to 3 mm. wide, obovate or broadly obovate to sublenticular, walnut brown to chocolate, scarcely exerted; glumes black, shining.

A medium-low variety, medium early in maturity, ripening in 105 to 112 days.

B. *Glumes buff to various shades of red.*

1. *Glume I flat, glume II keeled, not gibbous or ridged.*

a. *Inflorescence umbelliform, rachis shortened.*

\* *Panicle medium (9 to 11 inches); branches shorter.*

*Chihli Brush.* S. P. I. No. 18626. Plants 1.8 to 2.4 meters (6 to 8 feet) in height; panicles obovate or obconical, umbelliform, heavy, much branched, 2.2 to 2.7 dm. (9 to 11 inches) long; branches 1 to 1.7 dm. (4 to 7 inches) long; rachis about one-third as long as the panicle; spikelets 4.5 to 5.5 mm. long, obovate oval; glumes cinnamon red to brick red to black; seeds obovate, 4 to 5 mm. long by 3 to 4 mm. wide, cream buff to burnt sienna, exerted one-fourth to one-third. Time of maturing not recorded.

\*\* *Panicle elongated (12 to 18 inches); branches equaling the panicle.*

*Baird Brush.* S. P. I. Nos. 6406, 18614, 20706 (?) (G. I. No. 265) (fig. 9, c). Plants 1.8 to 2.7 meters (6 to 9 feet) in height; panicles very lax, 3 to 4.5 dm. (12 to 18 inches) long, umbelliform or with the rachis more or less produced, branches equaling the panicle, spreading and drooping, or appressed and the whole panicle nodding; spikelets oval, 4.5 to 6 mm. long; glumes shining, clay to tawny, 4 to 5 mm. long, covering three-fourths or more of the seed; seeds obovate to oval, clay to russet, one-fourth exerted, 4 to 5.5 mm. long by 3 to 3.5 mm. wide.

A medium to tall variety, medium late (120 days) in maturity, of value only as a possible stock for broom-corn experiments.

b. *Inflorescence paniculate; oval, ovate, or conical.*

\* *Panicle broadly oval, lax, heavy, 2.5 to 3.5 dm. (10 to 14 inches) long; rachis somewhat shortened, upper branches 1 to 1.2 dm. (4 to 5 inches) long, more than half as long as the lower; color effect, light brown.*

△ *Seeds large, broadly obovate or oval to sublenticular; glumes buff to cardinal and maroon.*

*Valley Brown.* S. P. I. Nos. 16792 (G. I. No. 152), 21078 (G. I. No. 273), 22911 (G. I. No. 309), 28057 (G. I. No. 423) (Pl. II, J; fig. 14, a, c). Plants 1.8 to 2.7 meters (6 to 9 feet) in height, stoutish, bearing 8 to 11 leaves, 7 to 9 cm. (2.7 to 3.5 inches) wide, and 6 to 6.7 dm. (2 to 2.2 feet) long; panicles large, broadly ovate or oval, heavy, 2.5 to 5 dm. (10 to 15 inches) long and half as wide, the lower branches 1 to 2 dm. (4 to 8 inches) long, the upper 1 to 1.2 dm. (4 to 5 inches) long; spikelets obovate, 4.2 to 5.7 mm. long; glumes mostly buff to clay, shading to cardinal, burnt sienna, and even maroon, seeds large, broadly obovate oval to sublenticular or subspherical, less flattened than most varieties, 3.5 to 5 mm. long by 2.5 to 4 mm. wide, cream, or mostly buff or clay, to russet, chestnut, and burnt umber.

A variety of medium height and early to medium-early maturity, ripening in 95 to 105 days. G. I. No. 309, especially, is considered very promising as a variety for middle latitudes and elevations.

△△ *Seeds large, oval to obovate; glumes paler.*

*Moose Brown.* S. P. I. No. 27555 (G. I. No. 414). Plants 2 to 2.4 meters (6.5 to 8 feet) in height, stoutish, 1.3 to 2.5 cm. (0.5 to 1 inch) in butt diameter; leaves 11 to 13 in number, 6 to 7.5 cm. (2.2 to 3 inches) wide, 7 to 7.5 dm. (2.2 to 2.5 feet) long; panicles large, lax, subconical or mostly one-sided and forming a right-angled triangle in shape, 2.5 to 3.5 dm. (10 to 14 inches) long, lower branches 7 to 15 cm. (3 to 6 inches) long, upper branches 1 dm. (4 inches) long; rachis about three-fourths as long as the panicle; spikelets 4.5 to 5 mm. long; glumes coriaceous, 4.5 to 5 mm. long, clay to burnt sienna or, in 1910 and 1911, a shining cream, edged with pink to hazel; seeds oval or obovate, 4 to 4.7 mm. long by 3 to 3.5 mm. wide, in original sample clay to chestnut, nearly included, much paler in 1910 and 1911. A variety of medium height and of medium-late maturity, ripening in 114 and 120 days in the two seasons tested.

\*\* *Panicle conical, lax, heavy, 2.5 to 3.5 dm. (10 to 14 inches) long; upper branches 5 to 7 cm. (2 to 2.8 inches) long; rachis nearly equaling the panicle.*

△ *Glumes, especially glume I, exceeding the seed, 5 to 6 mm. long.*

*Ware Brown.* S. P. I. No. 28027 (G. I. No. 421) (Pl. II, K). Plants 1.6 to 2 meters (5.5 to 6.5 feet) in height, slender to medium; leaves 10 to 11 in number, 7 to 8 cm. (2.7 to 3.2 inches) wide, 6 to 6.7 dm. (2 to 2.2 feet) long; panicles conical, lax, heavy (elliptic-oval in part of original plants), 2.5 to 3.5 dm. (10 to 14 inches) long, lower branches 1.2 to 1.7 dm. (5 to 7 inches) in length, upper branches 5 to 7 cm. (2 to 2.8 inches) long; rachis nearly equaling panicle; spikelets 4.5 to 5 mm. long; glumes raw sienna to Chinese orange and maroon or, in 1911, cream buff to cinnamon rufous, tinged with heliotrope; seeds obovate or oval, 4 to 4.5 mm. long by 3 to 3.8 mm. wide, clay to russet to burnt sienna, in 1910 clay tipped with hazel to brick red. A medium-low and early to medium-early variety, ripening in 92 days in 1910 and in 92 to 110 days in 1911.



△△ *Glumes equaling or shorter, especially glume II, than the seed, 4 to 5 mm. long.*

+ *Peduncles red.*

*Redstem.* S. P. I. No. 22011 (G. I. No. 327). Plants medium, 1.8 to 2.7 meters (6 to 9 feet) in height; slender to medium in diameter and usually without suckers; culms, especially the upper internodes, peduncle and rachis a beautiful madder brown or maroon; leaves 9 to 12 in number, 5 to 7 cm. (2 to 2.7 inches) wide, 6 to 6.7 dm. (2 to 2.2 feet) long; panicles sparse, light weight, lax, ovate or becoming one-sided by the bending of the peduncle, 2.2 to 3 dm. (9 to 12 inches) long, the lower branches 7 to 15 cm. (3 to 6 inches) long, spreading; rachis nearly equaling the panicle; spikelets large, oval, or suboval, 4.5 to 6 mm. long; glumes orange vermilion to maroon, occasionally buff; seeds oval or obovate oval, 4 to 5 mm. long by 3 to 3.7 mm. wide, cream buff to hazel to bay, one-fifth exserted. An early variety of medium height, ripening in 95 days, and strikingly characterized by the reddish brown stems. Of little value because of the light, sparse panicle.

++ *Peduncles straw color.*

○ *Lower panicle branches 1.2 to 1.6 dm. (5 to 6.5 inches) long.*

† *Branches stout, rigid; seeds acute.*

*Parker Brown.* S. P. I. No. 28058 (G. I. No. 424) (Pl. II, L). Plants 1.8 to 2.1 meters (6 to 7 feet) in height, 1.2 to 2 cm. (0.5 to 0.8 inch) in diameter at the butt; leaves 10 to 12 in number, 9 to 10 cm. (3.5 to 4 inches) wide, 6 to 6.7 dm. (2 to 2.2 feet) long; panicles exserted 7 to 15 cm. (3 to 6 inches), narrowly elliptical, 2.2 to 3 dm. (9 to 12 inches) long; branches stout, rigid, the lower 1 to 1.5 dm. (4 to 6 inches) in length; rachis three-fifths as long as the panicle; spikelets 4 to 5 mm. long; glumes vinaceous cinnamon to maroon to black in 1910, and clay to hazel to chestnut in 1911; seeds rhombic oval to obovate, acute, 3.5 to 5 mm. long by 3 to 4 mm. wide, buff to burnt sienna in the original and in 1911, in 1910 cream to raw sienna to hazel. A variety of medium height and early maturity, ripening in 92 and 96 days in the two seasons tested.

†† *Branches slender, flexible; seeds obtuse.*

= *Seeds elliptical or narrowly oval.*

*Shasi Brown.* S. P. I. No. 21678 (G. I. No. 278) (Pl. II, M). Plants 1.9 to 2.4 meters (6.5 to 8 feet) in height, culms 2 to 2.5 cm. (0.7 to 1 inch) in butt diameter; leaves 10 to 11 in number, 5 to 6.5 cm. (2 to 2.5 inches) wide by 6.7 to 7.5 dm. (2.2 to 2.5 feet) long; panicles broadly conic, or one-sided from the leaning of the culms, 2.7 to 3.5 dm. (11 to 14 inches) long, exserted 2.5 to 7.5 cm. (1 to 3 inches), branches slender, flexible, the lower 1 to 2 dm. (4 to 8 inches) long, the upper 6 to 7 cm. (2.5 to 3 inches) long; spikelets 4 to 5.3 mm. long; glumes 3.5 to 4 mm. long, clay and tawny to orange vermilion, ferruginous and crimson; seeds oval, broadly oval or obovate, 3.8 to 4.7 mm. long by 2.8 to 3.6 mm. wide, mostly russet or some burnt umber in original sample, cream buff to burnt sienna in 1911, about one-third exserted. A variety of medium stature and maturity, ripening in 110 days in the single test made.

== *Seeds broadly oval to sublenticular.*

*Pecsan Brown.* S. P. I. Nos. 17922 (G. I. No. 122), 24990 (Pl. II, N). Plants 1.8 to 2.4 meters (6 to 8 feet) in height, bearing 9 to 11 leaves, 9 to 11 cm. (3.5 to 4.5 inches) wide, 6 to 6.7 dm. (2 to 2.2 feet) long; suckers 1 to 3 in number; panicles conical, 1.5 to 2.7 dm. (6 to 11 inches) long, mostly one-sided by the flexing of the peduncle; branches slender, the lower 1 to 1.5 dm. (4 to 6 inches) long; spikelets oval, 4 to 5.6 mm.

long; glumes covering three-fourths of the seed, clay to madder brown; seeds mostly oval, some broadly obovate, 3.5 to 5 mm. long by 3 to 4 mm. wide, russet to bay in original, some of the later generations cream buff to raw sienna to hazel.

The original was a considerable mixture from which has been isolated the low and medium-early strain, G. I. No. 122, 4.5 to 5.5 feet in height and maturing in 110 to 115 days.

○○ *Lower panicle branches 5 to 10 cm. (2 to 4 inches) long.*

*Ichang Brown.* S. P. I. No. 21676 (G. I. No. 276). Plants about 2 meters (7 feet) high, culms stout, 2.5 to 3 cm. (1 to 1.2 inches) in butt diameter; leaves 11 to 13 in number, 7 to 9 cm. (3 to 3.7 inches) in width, 7.5 to 8 dm. (2.5 to 2.7 feet) long; panicles conical, loose, 2.7 to 3.2 dm. (11 to 13 inches) long, exerted 2 to 7.5 cm. (1 to 3 inches), lower branches 0.5 to 1 dm. (2 to 4 inches) long, upper branches 3 to 5 cm. (1 to 2 inches) long; spikelets obovate oval, 4 to 4.8 mm. long; glumes clay and cardinal to madder brown and claret brown; seeds broadly oval to obovate oval, 3.5 to 4.5 mm. long by 2.8 to 3.8 mm. wide, cream to chestnut to burnt sienna. A variety of medium height and medium maturity, ripening in 110 days in the single test made. Distinguished from Peesan Brown chiefly by the longer heads and darker glumes. Quite probably it is equivalent to one of the forms discarded from S. P. I. No. 17922, from which Peesan Brown was selected.

\*\*\* *Panicles small, oval, compact, 3 to 6 inches long; seeds small, broadly obovate to sublenticular.*

*Chusan Brown.* S. P. I. Nos. 23230 (G. I. No. 323), 23231 (G. I. No. 324) (Pl. II, O). Plants low to medium, 1.2 to 2 meters (4 to 7 feet) in height, bearing 8 to 10 leaves, 8 to 10 cm. (3.2 to 4 inches) wide, 6.7 to 7.5 dm. (2.2 to 2.5 feet) in length; panicles small, 1.2 to 2 dm. (5 to 8 inches) long, narrowly oval, lower branches 2 to 3.5 inches long, seeded to their base, rachis equaling the panicle; spikelets broadly obovate, 3.5 to 4.2 mm. long; glumes short, brick red to maroon or chestnut to bay, shining; seeds small, broadly obovate or sublenticular, 3 to 4 mm. long by 2.5 to 3.5 mm. wide, bay to burnt umber to chocolate. A low to medium variety with small, compact panicles and small, nearly round seeds; medium to medium late, ripening in 110 to 129 days. Of little promise.

2. *Glumes gibbous at the base, transversely ridged above the middle, with depressed tip.*

a. *Spikelets small, broadly obovate or sublenticular; panicle large, lax; plant medium height.*

*Tokyo Brown.* Agrost. Nos. 1576, 1586; S. P. I. Nos. 4905 (G. I. No. 277), 21677 (Pl. II, P). Plants 1.5 to 2.1 meters (5 to 7 feet), slender to medium, suckering freely; leaves 11 to 12 in number, 8 to 10 cm. (3.5 to 4 inches) wide, 7.5 to 8.2 dm. (2.5 to 2.7 feet) in length; panicles lax, ovate-conical, large, 2 to 3.5 dm. (8 to 14 inches) long, heavy, apex often nodding, branches 1 to 1.5 dm. (4 to 6 inches) long, ascending or spreading and nodding at the apex; spikelets mostly 3 to 4 mm. long, almost spherical; glumes coriaceous, short, transversely shouldered or ridged, the apex depressed and closely appressed to the seed, clay to brick red or vinaceous cinnamon to maroon in the first two and last forms, from mostly cream buff through heliotrope to burnt sienna and claret brown in the third; seeds 3 to 4 mm. by 2.5 to 3.8 mm. in size and mostly chestnut to burnt sienna or darker, very broadly obovate to nearly lenticular in the first two and last, still smaller, rounder, and clay or dark clay in the third. A low to medium variety of medium maturity, ripening in about 110 days.

*b. Spikelets medium to large, oval; panicle small to medium, compact.*

*\* Plant medium; spikelets medium; panicle small, slender.*

*Choonchun.* S. P. I. No. 27554 (G. I. No. 413) (Pl. II, Q). Plants slender, 1.3 to 2 meters (4.5 to 6.5 feet) tall, medium stout, bearing 10 to 12 leaves, 7.5 to 9 cm. (3 to 3.5 inches) wide, 6 to 6.7 dm. (2 to 2.2 feet) long; panicle small, cylindric oval, compact, 1.5 to 2 dm. (6 to 8 inches) long, with continuous rachis, lower branches 7.5 to 10 cm. (3 to 4 inches) long; spikelets ovate or broadly oval, 4.5 to 5 mm. long; glumes 3 to 3.5 mm. long, clay to orange vermilion to deep crimson, edged with dark brown, covering two-thirds of the seed; seeds broadly oval or obovate oval, 4 to 5 mm. long by 3 to 3.8 mm. wide, clay to russet to burnt umber, or cream buff to brick red in 1910. A low variety of medium-early maturity, ripening in 103 and 98 days in the two seasons grown. Not promising.

*\*\* Plant very dwarf; panicle heavy, compact, oval; spikelets large.*

*Shantung Dwarf.* S. P. I. No. 22010 (G. I. No. 293) (Pl. II, R; fig. 13; fig. 14b). Plants stout, very dwarf, 0.6 to 0.9 meter (2 to 3 feet) tall, averaging 2.5 cm. (1 inch) in diameter at the butt; leaves 8 to 11 in number, 1 to 1.2 dm. (4 to 4.8 inches) wide, 5.2 to 6 dm. (1.7 to 2 feet) in length; panicles stout, heavy (averaging 3 ounces each) oval, compact, 2 to 2.5 dm. (8 to 10 inches) long; spikelets broadly oval, occasionally obovate or even ovate, 4 to 5.5 mm. long; glumes 3.5 to 4 mm. long, gibbous at the base, transversely ridged above the center, the apex depressed and closely appressed to the seed, buff to burnt sienna or in later years cream to clay and madder brown; seeds broadly oval or obovate, 4 to 5 mm. long by 3 to 4 mm. wide, one-third exerted, russet to burnt umber, or, in later years, raw sienna to burnt sienna. A very dwarf, medium-early variety, 2 to 3 feet in height, and maturing in 100 to 110 days.

#### AGRICULTURAL VALUE.

##### GENERAL CHARACTERS.

The kaoliangs have been too recently introduced and have required too much rigid selection to allow final judgment as to their place among the grain varieties. They are of almost no value as forage, owing to the dry stems and the few and small leaves. They are not likely to displace any of the leading groups of grain sorghums, such as the milos, durras, and kafirs, now grown in this country. At the same time, on account of their earliness, and perhaps greater hardiness also, they have apparently a distinct place of their own to fill in the more northern and more elevated parts of the dry-farmed areas.

As previously stated, the kaoliang varieties, when introduced from the Orient, are frequently mixtures of varieties and almost certainly mixtures of races or strains also. In order to obtain uniformity and value as grain producers it has been necessary to isolate the highest producing strains by the head-to-row method. Table V shows the number of varieties or separate introductions under test since 1906 and also the number of selections made each year and the number of these selections which were planted the succeeding season.



TABLE V.—Record of kaoliang varieties or introductions under test at the experiment farm of the Office of Grain Investigations at Amarillo, Tex., since 1906, and the number of selections made therefrom annually.

Year.	Planted.				Selections made.		
	Number of lots—			Number of select heads.	Number of lots—		Number of heads selected.
	From original seed.	From select heads.	Total.		Discarded.	Selected.	
1906	6	0	6	0	1	5	43
1907	11	5	16	43	3	13	391
1908	6	11	17	243	2	15	479
1909	5	11	16	150	1	15	610
1910	7	15	22	164	0	22	440
1911	3	22	25	186	0	25	255

The group contains a large assortment of varieties, some early, some late; some dwarf, some tall; some compact, some lax in panicle; some with large seeds and some with small. They all unite in having small to medium stalks, containing dry pith and bearing comparatively few (6 to 11) leaves. Since the crop has so little forage value the tall varieties are not desirable. The late varieties are usually tall also, but even if they were not they would have no advantage, except possible lower water requirements, over the equally late kafirs in regions where late sorts can be matured. The medium-maturing varieties of medium or low stature must compete with the well-known and popular milo varieties as grain producers and are of even less value for forage. Their chief advantage is their always erect head. It follows, then, that there is real need at present for only the very early strains which can be matured farther north and at higher elevations than milos. Such varieties have been obtained, improved by some years of selection, and are now giving good results in South Dakota and other points farther north, as well as on the elevated plains of New Mexico and Colorado.

Owing to their low water requirements and tendency to produce but one stalk from a seed it has been possible to mature good crops of kaoliangs in dry years where milo largely failed. If moisture is comparatively abundant in the early part of the growing period, milo is likely to put forth so many suckers as to seriously handicap the crop when dry weather sets in. The kaoliangs are less prolific in this regard and can therefore endure drought more successfully. This fact gives value to the kaoliangs in the drier parts of the central Plains area. The kaoliangs seem also to be slightly less susceptible to chinch-bug injury than the milos, though more so than the kafirs.

#### PROMISING VARIETIES.

Out of the considerable number of actual varieties tested and classified, only a few give promise of definite value for definite areas.

All of these are early or medium in maturity. The later varieties are not only tall, which is objectionable, but can scarcely compete with the popular milo and kafir varieties.

From the standpoint of the characters and quality of the seed there is probably but little to choose among the varieties. The members of the white-seeded section are perhaps preferable because the seed coats contain no tannin. But because of this very fact they are the more eagerly sought by birds. Small fields are often severely damaged by the inroads of English sparrows, blackbirds, and other species. To date it is true also that the earliest forms in the white-seeded section are appreciably later than the earliest of the brown-seeded sorts. However, earlier white strains are being evolved and the present superiority of the brown varieties in this respect is likely to be diminished gradually.

As to other characters than color of the seed there is little choice among the different varieties except in earliness. For use at high elevations and in northerly latitudes the very earliest strains must be chosen. Under more favorable conditions any of the best producing varieties may be safely used.

*Tests in the Texas Panhandle.*—Table VI shows the performance of some of the best sorts at the Amarillo experiment farm of the Office of Grain Investigations during the past four years. Some of these varieties were under experiment at that point previous to 1908, but pure strains were not available for plat tests before that year. In 1908 most of the tests were in hundredth-acre or fiftieth-acre plats. In 1909, 1910, and 1911 all the standard sorts were tested in one or more tenth-acre plats. The yields recorded for 1910 and 1911 are often the average of several tenth-acre plats, in one case as many as seven being averaged.

TABLE VI.—*Length of growing period, height, and yield per acre of several varieties of kaoliang at the experiment farm, Amarillo, Tex.*

G. I. No.	Variety.	Growing period.	Height.	Yields per acre.				
				1908	1909	1910	1911	Average.
		<i>Days.</i>	<i>Feet.</i>	<i>Bush.</i>	<i>Bush.</i>	<i>Bush.</i>	<i>Bush.</i>	<i>Bush.</i>
120.....	Brill Blackhull.....	120-135	7-12	.....	.....	1.84	19.31	10.57
412.....	Korean Blackhull.....	100-105	6-8	.....	.....	*10.34	15.96	13.15
310.....	Barchet Blackhull.....	100-110	4.5-5.5	*43.10	†9.44	8.58	†30.75	22.97
190.....	Mukden White.....	105-115	5-8	.....	12.80	12.19	25.07	16.68
272.....	do.....	100-115	6-8	*18.10	15.74	*7.24	21.18	15.56
123.....	Tientsin Brown.....	105-120	7-8	*31.31	9.89	6.52	27.50	18.80
193.....	Kali Brown.....	100-110	5-8	*26.29	12.82	9.95	25.05	18.53
171.....	Manchu Brown.....	90-100	4.5-6	†33.38	†14.19	†14.32	29.29	22.77
261.....	do.....	85-95	4.5-6.5	20.85	11.43	6.16	†18.99	13.86
328.....	do.....	85-95	4.5-6	.....	.....	7.45	†21.36	14.40
309.....	Valley Brown.....	95-105	6	*37.41	16.03	†15.01	30.98	24.86
122.....	Peesan Brown.....	110-115	5-6	†33.86	†14.76	11.69	28.85	21.79
324.....	Chusan Brown.....	110-120	4-6	.....	.....	*6.47	21.30	13.89
293.....	Shantung Dwarf.....	105-110	2.5-3	*33.62	3.49	6.64	27.62	17.84

\* Less than a twentieth-acre plat.

† Average of two or more tenth-acre plats.

The yields for the first three years are in decreasing series, due to severe climatic conditions. The rainfall for the past five years at the Amarillo farm is shown in the following table:

TABLE VII.—*Precipitation in inches per month at Amarillo, Tex., for five years from 1907 to 1911.*

Years.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1907.....	1.11	0.24	0.02	1.25	0.99	1.97	1.49	6.20	0.91	1.79	0.66	1.46	18.09
1908.....	.26	.72	T.	1.90	3.55	1.73	5.40	2.75	1.83	.40	.51	.00	19.05
1909.....	.07	.28	1.28	.50	1.08	4.72	3.63	.87	2.19	1.18	3.25	.54	19.59
1910.....	.05	.17	.34	.53	2.61	1.15	2.94	2.44	.05	.13	.19	T.	10.60
1911.....	.13	2.88	.50	2.76	5.88	.20	3.85	2.97	.83	.84	.94	.95	22.73

The rainfall of four of these five years was below the average for the 15 years preceding 1907, which was 22.5 inches. The yields recorded for 1908 are good, those for 1909 average less than half as large, while those of 1910 are still lower. In 1911 the yields rise again. The discrepancy in the yields of 1908 and 1909 does not arise from a difference in annual precipitation, but from the difference in seasonal distribution and in part from the cumulative effect. In 1908 the rainfall was abundant during the six months, April to September, which determine the success of these summer crops, being highest in May, the month of planting, and in July, the month of greatest growth. In 1909, on the other hand, the season was dry until June, and August, the month of heading or ripening, was also very dry. The yields of the year 1910 are readily explained by the very deficient rainfall following a fairly dry season in 1909. The average yields for the four years are very good, considering the seasonal conditions. That four of these kaoliang varieties should have been able to produce average yields of more than 20 bushels an acre under the conditions obtaining in these four years is very gratifying. Five other varieties or strains made average yields ranging from 13.8 bushels to 18.8 bushels in the same period. The average yield for these nine strains is 19.7 bushels for the four-year period.

In comparison with the above records, nine varieties of corn made an average yield in 1908 of only 10.06 bushels per acre. In 1909 a larger number of varieties ranged from nothing to about 7 bushels in yield, while in 1910 no yields whatever were obtained. In 1911 the average yield of 26 varieties was 4.27 bushels per acre. The best variety of corn, a red dent of local origin, averaged only 10.02 bushels for this four-year period. The three-year average of all corn varieties was certainly much below 5 bushels.

*Tests in the central Plains area.*—The performance of these kaoliangs at Amarillo may be taken as a fair sample of what may be expected of them in the grain-sorghum belt or the southern half of



the Great Plains area, due allowance being made for differences in elevation, rainfall, etc. Similar results have been obtained at the experiment farm, Dalhart, Tex., in cooperation with the Office of Dry-Land Agriculture. Tests by large numbers of cooperating farmers in Oklahoma, Kansas, New Mexico, and Colorado have given results as good as or better than those cited above.

The choice of varieties from among the best recorded in Table VI will be governed largely by the need for earliness. For Texas, Oklahoma, and western Kansas such varieties as Barchet Blackhull and Manchu Brown, Kali Brown, Valley Brown, and Peesan Brown are well adapted. For the higher elevations in New Mexico and Colorado as well as for western Nebraska and South Dakota only the earliest strains of Manchu Brown are certain to mature.

Manchu Brown, as noted in the discussion of introductions, is a very early variety of low stature originating in Manchuria. It was obtained from several widely separated localities of that division and is probably the dominant, if not, indeed, the only variety grown in the higher latitudes of Manchuria and the adjacent provinces of Siberia. It is possible that its northern origin has given it the power of germinating at lower mean daily temperatures than varieties originating farther south. At any rate, better stands are usually obtained from strains of this variety in the Dakotas and Montana than from any other kaoliangs or any other group of grain sorghums.

*Tests in South Dakota.*—Three strains of Manchu Brown have been successfully grown in South Dakota. These are G. I. Nos. 171, 261, and 328. The exact origin of the first two is not known, but the last comes from the Harbin district, in the province of Kirin, at 46° north latitude, or higher. The tests were made at the Highmore substation in cooperation with the department of agronomy of the South Dakota Agricultural Experiment Station, and the earlier results have already been published by Willis and Champlin,<sup>1</sup> of that station.

The latitude of Highmore is 44.5° north, the elevation 1,890 feet, the average annual rainfall 17.4 inches, and the soil a glacial clay loam.

Table VIII contains the data obtained in these tests during 1909 and 1910, adapted from the table on page 54 of the bulletin cited, with the data for 1911 added. The average yield of the three strains for the two years is seen to be 16.5 bushels, and for the three years 13.7 bushels per acre. These kaoliangs were tested each year in tenth-

<sup>1</sup> Willis, Clifford, and Champlin, Manley. Progress of Grain Investigations. Bulletin 124, South Dakota Agricultural Experiment Station, November, 1910, p. 54.

acre plats, drilled in rows 3.5 feet apart with a row space of about 6 inches for each plant.

The year 1910 was deficient in rainfall at Highmore, and 1911 will long be remembered for the drought prevailing during the growing season of these crops.

TABLE VIII.—*Results with Brown Manchu and Barchet Blackhull kaoliangs at Highmore (S. Dak.) substation, 1909 to 1911.*

Year.	Data of test.	Varieties.			
		Manchu Brown.			Barchet Blackhull, G. I. No. 310.
		G. I. No. 171-8, Highmore No. 92.	G. I. No. 261-4, Highmore No. 91.	G. I. No. 328, Highmore No. 90.	
1909....	Planted.....	May 19	May 19	May 19	May 19
	Headed.....	Aug. 7	Aug. 4	Aug. 1	Aug. 14
	Ripened.....	Sept. 12	Sept. 10	Sept. 10	Oct. 12
	Days to mature.....	117	114	114	146
	Yield.....bushels..	14.8	14.0	14.8	2.4
1910....	Planted.....	May 18	May 18	May 18	.....
	Headed.....	July 30	Aug. 2	Aug. 2	.....
	Ripened.....	Sept. 12	Sept. 9	Sept. 7	.....
	Days to mature.....	116	114	110	.....
	Yield.....bushels..	19.2	20.0	16.4	18.5
	Average yield for 2 years.....do....	17.0	17.0	15.6	16.5
1911....	Planted.....	May 19	May 19	May 19	.....
	Headed.....	Aug. 4	July 31	Aug. 1	.....
	Ripened.....	Sept. 5	Sept. 1	Sept. 1	.....
	Days to mature.....	109	105	105	.....
	Yield.....bushels..	10.3	6.0	8.2	8.2
	Average yield for 3 years.....do....	14.8	13.3	13.1	13.7

Fifteen varieties of corn grown in 1909 gave an average yield of 18.2 bushels per acre. The varietal test, continued for three years, was then abandoned and only the two best varieties were grown in 1910. Eighteen plats of Minnesota No. 13 averaged 7.5 bushels, and fourteen plats of Brown County Yellow averaged 9.7 bushels per acre. In 1911 a single ear-row plat of each was grown, yielding 15.3 and 6.8 bushels per acre, respectively.

At the Bellefourche experiment farm, Newell, S. Dak., experiments are conducted in cooperation with the Office of Western Irrigation Agriculture. The latitude is 44.7° north, the elevation 2,900 feet, the average annual precipitation 14 or 15 inches, and the soil a heavy clay or gumbo. The effects of the increased altitude and latitude, heavier soil, and lower precipitation are indicated by the results given in Table IX. The tests were conducted by Mr. Cecil Salmon, in charge of grain investigations at that station.

In 1909 the strains were tested in hundredth-acre head rows, except No. 171, which was in a tenth-acre plat. In 1910 all strains

were tested in two-hundredth-acre head rows. While the yields so far obtained are not high, they give promise that further selection will result in profitable strains. The spring and summer of 1911 were exceedingly dry. The seed of none of the spring-sown small grains germinated and therefore no grain sorghums were planted.

TABLE IX.—*Results with Manchu Brown kaoliang at Bellefourche experiment farm, Newell, S. Dak., in 1909 and 1910.*

Year.	Data of test.	G. I. No. 171.	G. I. No. 261-3-1.	G. I. No. 261-3-2.	G. I. No. 261-3-3.	G. I. No. 261-3-4.	G. I. No. 261-3-5.	G. I. No. 261-4.	G. I. No. 328.	Aver- age.
1909..	Planted.....	June 14	June 5	June 5	June 5	June 5	June 5	June 5	June 14	.....
	Headed.....	Aug. 25	Aug. 23	Aug. 23	Aug. 24	Aug. 24	Aug. 23	Aug. 24	Aug. 25	.....
	Ripened.....	Sept. 20	Sept. 18	Sept. 18	Sept. 18	Sept. 18	Sept. 18	Sept. 18	Sept. 20	.....
	Days to mature.....	*98	105	105	105	105	105	105	98	.....
	Yield.....bushels..	12.7	19.0	5.7	8.5	6.6	13.3	12.3	9.5	10.95
1910..	Planted.....	May 23	.....	.....	.....	.....	May 23	May 23	May 23	.....
	Headed.....	Aug. 12	.....	.....	.....	.....	Aug. 12	Aug. 15	Aug. 9	.....
	Ripened.....	Sept. 30	.....	.....	.....	.....	Sept. 30	Sept. 30	Sept. 30	.....
	Days to mature.....	130	.....	.....	.....	.....	130	130	130	.....
	Yield.....bushels..	7.66	.....	.....	.....	.....	13.22	12.45	8.62	10.49
	Average yield for 2 years...bushe.s..	10.18	.....	.....	.....	.....	13.26	12.37	9.06	11.22

\* Not fully mature.

† Four selections only.

The three strains of Manchu Brown matured from 0.45 of a bushel to 1.2 bushels at the substation at Dickinson, N. Dak., in 1909, but were killed by frost without ripening in 1908 and 1910. In 1911 two strains ripened a little seed at Dickinson and also at Williston, in the northern part of the State. In Montana they have not yet been able to ripen successfully, though the results in 1911 with early strains from South Dakota have been quite promising. In parts of Idaho some good yields have been obtained by a few cooperating farmers. These strains give promise of value at the substation at Moro, Oreg., but it is too early to speak definitely as to their value there.

#### CULTURE OF KAOLIANGS.

The varieties of the kaoliang group are handled in all respects as are the other and better known groups of grain sorghums, viz., milo, durra, kafir, etc. The seeds of the kaoliangs are similar to those of the kafir varieties in size and shape, and the same adjustment of the planter will cause the same rate of seeding of both. They should be drilled in rows approximately  $3\frac{1}{2}$  feet apart, with a row space for each plant varying from 6 to 12 inches, according to climatic conditions. It is probable that under the conditions obtaining in the southern part of the Plains area in average or favorable seasons, a stand of one stalk to each 5 or 6 inches will give the best results. At higher elevations, or farther north, or in dry seasons thinner stands will be desirable. In regions subject to the frequent recurrence of



dry seasons, and this probably includes all the so-called semiarid areas of the West, it is probable that a thin planting of a portion of the area devoted to grain sorghums each year will serve in a measure as insurance against a total loss of the crop. This practice has been followed in past years by a number of farmers with very good results. Like other grain sorghums, they should not be sown until the danger of spring frosts is well past.

#### SUMMARY.

The kaoliangs are a distinct group of grain-producing sorghums only recently introduced from eastern Asia.

They are found throughout the eastern half of the Chinese Empire, except in the low southeastern provinces, and extend northward and eastward through Manchuria and Chosen (Korea) to Japan. They are most abundantly grown in the northern part of this area, especially in Chihli and Manchuria.

No other sorghums are found in the region named except a variety of sorgo cultivated locally on and about Tsungming Island in the mouth of the Yangtze River. They are probably the descendants of varieties imported into China from India many centuries ago.

In the Orient the seed is used both for human and animal food and in the manufacture of liquor. The stalks are used for both fodder and fuel. In addition, the stems and leaves are used as material for thatching, fences, hedges, light bridges, and other building. They are also used in certain native manufactures, such as baskets, matings, window shades, etc. The brush of some varieties is used for native brooms.

Varieties of kaoliang were introduced into this country as early as about 1866, and again at subsequent times, but were discarded after brief cultivation for sugar production. Since 1898, 49 direct and 3 indirect introductions from eastern Asia have been made, representing more than half as many distinct varieties.

Most of these introductions have been tested by the writer through a series of years and at a number of stations, from the agricultural and varietal standpoints. Since 1906, all introductions have been tested for grain production. Those giving any promise of value have been subjected to head-to-row breeding for pure strains.

Descriptions of the plant and seed characters of all the introductions and a description of the group as a whole are presented in this paper.

Twenty-seven distinct varieties of kaoliang are named and described for the first time, with complete keys for their separation.

The kaoliangs are good grain producers, though of little value for forage on account of their scanty foliage. They are not likely to

displace any of the present groups of grain sorghums, such as the milos, durras, and kafirs, but on account of their earliness apparently have a distinct place of their own to fill in the more northern and more elevated parts of the dry-farmed areas.

The earliest variety, Manchu Brown, matures in 85 to 95 days in the southern Plains area, and in 100 to 110 days as far north as South Dakota. A number of high-yielding varieties mature in 110 days or less.

Of nine strains thoroughly tested at the Amarillo experiment farm from 1908 to 1911, inclusive, four produced average yields of more than 20 bushels per acre and the other five produced from 13.8 to 18.8 bushels per acre. The average yield for the nine strains was 19.7 bushels for the four-year period. The annual rainfall of the first three years was below normal and the seasonal rainfall was deficient in the middle two. Average yields of corn varieties under the same conditions were less than 5 bushels.

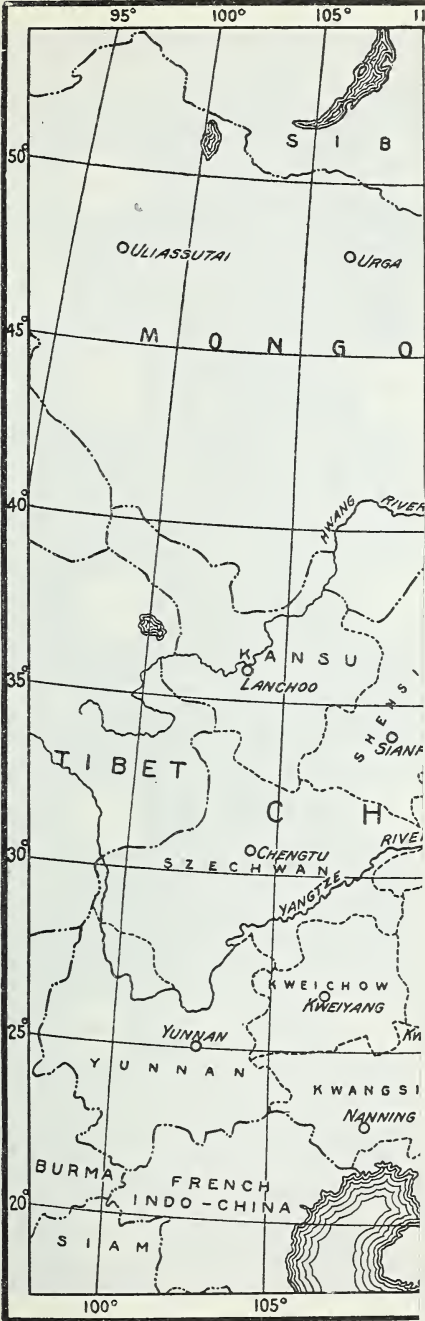
The strains of the extra-early Manchu Brown have been under test at various points in the Northwest during 1909, 1910, and 1911. At the substation at Highmore, S. Dak., they have produced an average yield of 13.7 bushels in the three-year period. At the Belle-fourche experiment farm, Newell, S. Dak., four strains gave a two-year average of 11.2 bushels per acre.

Promising results are being obtained at other points at high elevations or in high latitudes.

#### DESCRIPTION OF PLATES.

PLATE I. Map of eastern Asia, showing the provinces and larger cities of China, Manchuria, and Chosen (Korea).

PLATE II. Spikelets and seeds of kaoliang varieties: *A*, Brill Blackhull, S. P. I. No. 17920 (G. I. No. 120); *B*, Korean Blackhull, S. P. I. No. 27553 (G. I. No. 412); *C*, Barchet Blackhull, S. P. I. No. 22912 (G. I. No. 310); *D*, Mukden White, S. P. I. No. 18610 (G. I. No. 190); *E*, Hansen Brown, S. P. I. No. 17921 (G. I. No. 121); *F*, Tientsin Brown, S. P. I. No. 17923 (G. I. No. 123); *G*, Kali Brown, S. P. I. No. 19187 (G. I. No. 193); *H*, Manchu Brown, S. P. I. No. 18518 (G. I. No. 171); *I*, Hankow Brown, S. P. I. No. 6604 (in part) (G. I. No. 326); *J*, Valley Brown, S. P. I. No. 22911 (G. I. No. 309); *K*, Ware Brown, S. P. I. No. 28027 (G. I. No. 421); *L*, Parker Brown, S. P. I. No. 28058 (G. I. No. 424); *M*, Shasi Brown, S. P. I. No. 21678 (G. I. No. 278); *N*, Peesan Brown, S. P. I. No. 17922 (G. I. No. 122); *O*, Chusan Brown, S. P. I. No. 23231 (G. I. No. 324); *P*, Tokyo Brown, S. P. I. No. 21677 (G. I. No. 277); *Q*, Choonchun Brown, S. P. I. No. 27554 (G. I. No. 413); *R*, Shantung Brown, S. P. I. No. 22010 (G. I. No. 293). (All natural size.)



MAP OF EASTERN ASIA, SHOWING THE







MAP OF EASTERN ASIA, SHOWING THE PROVINCES AND LARGER CITIES OF CHINA, MANCHURIA, AND CHOSEN (KOREA).







SPIKELETS AND SEEDS OF KAOLIANG VARIETIES.







